A Scranton Gillette Publication

AUGUST 1959

WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

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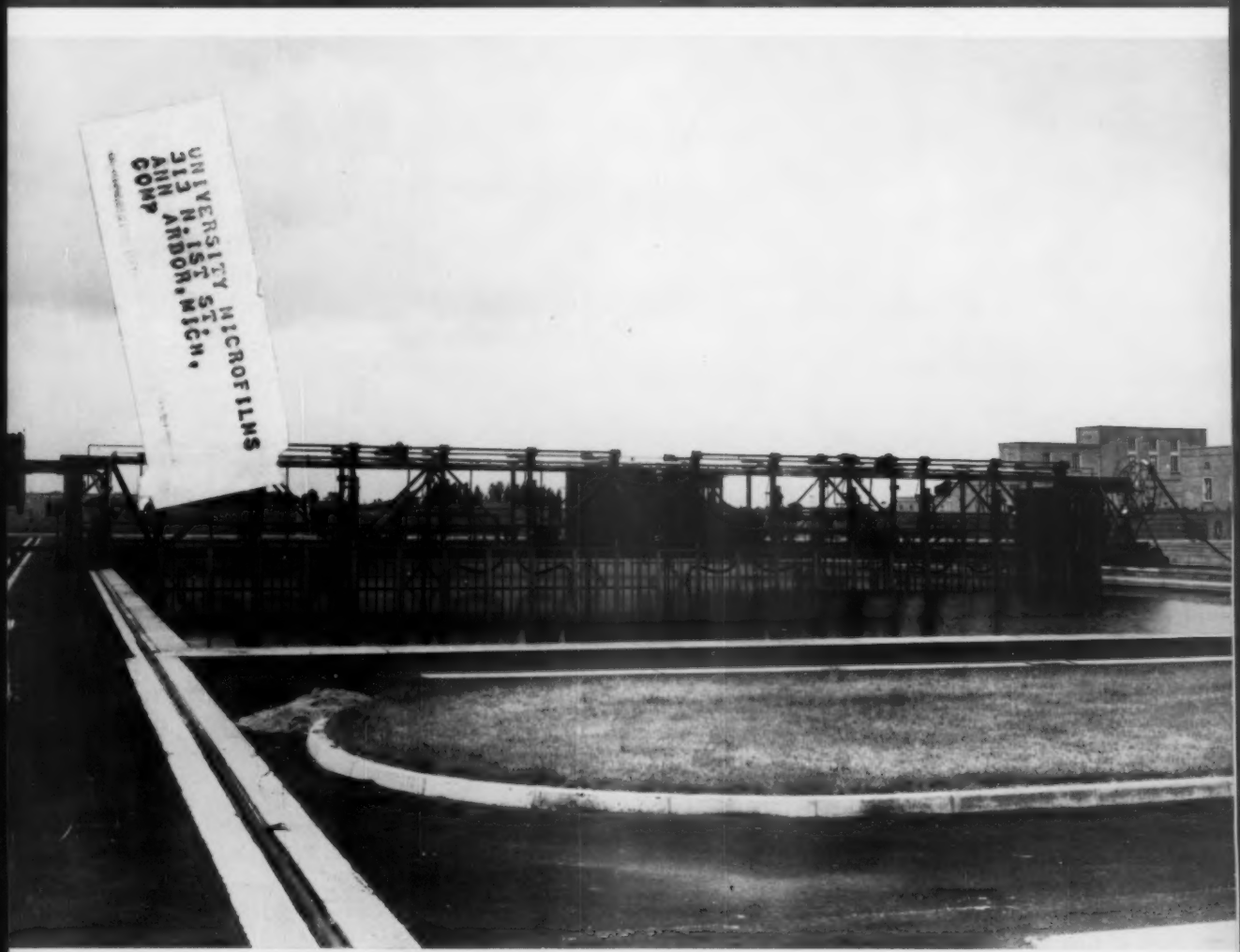

▲ **HYDRAULIC SAND WASHING** machine is carried on a gantry traveling on rail tracks between filter beds. This machine cleans without removing the sand or emptying the bed.

Survey—Sludge Aeration Methods pp. 333

Meter Repair Shop pp. 324

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Complete Process Instrumentation

Vol. 106 No. 8
AUGUST • 1959

A Scranton Gillette Publication

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WATER & SEWAGE WORKS

NEW TREATMENT PLANT *for Metropolitan London Water*
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TRENCH PREPARATION *and Pipe Bedding is part two of the construction supervision series*
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PENNA. AWWA SECTION MEETING *reports the eleventh annual gathering*
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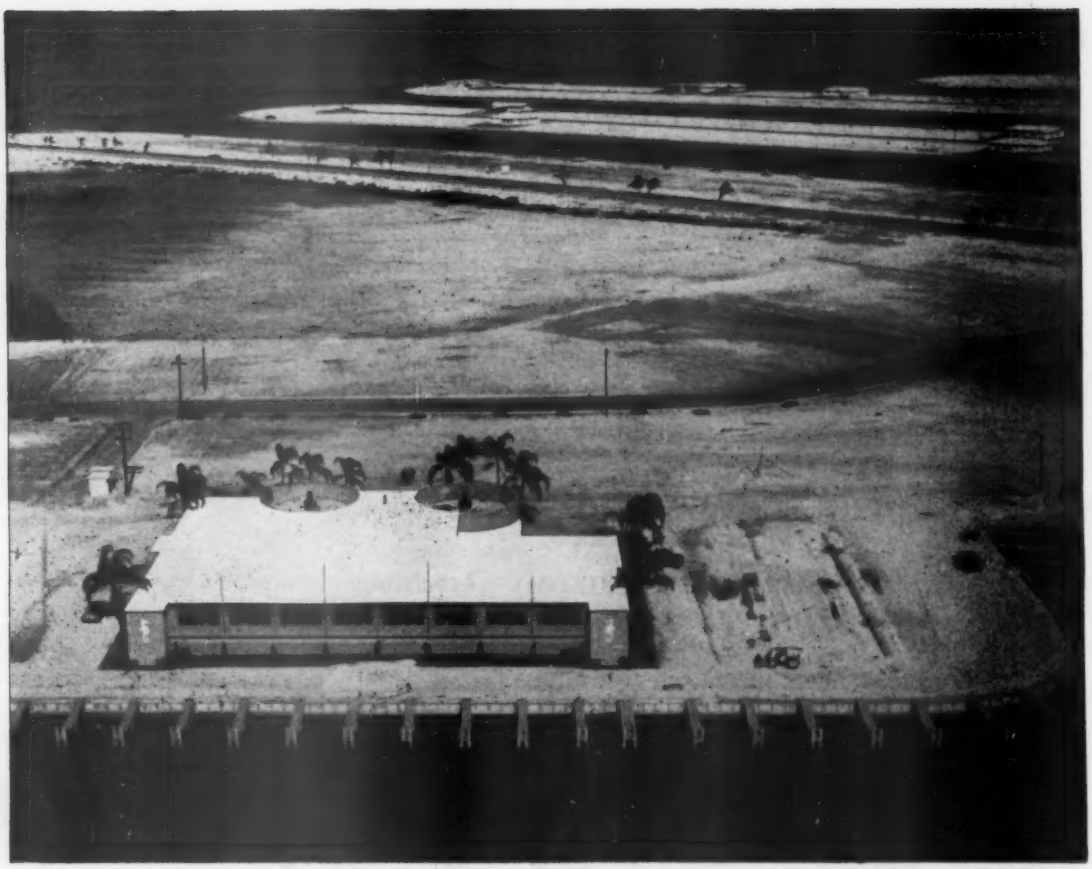

Clearwater, Florida's new Marina Station Sewage Treatment Plant serves the Clearwater Beach area and Marina facilities for this growing resort area. P.F.T. equipment plays an important part in this attractive, modern plant. *Briley, Wild & Associates, Daytona Beach, were the Consulting Engineers.*

Clearwater's new treatment plant enhances boating facilities for resort area

In the midst of the much sought after marina mooring facilities this architecturally attractive, completely enclosed treatment plant blends into the recreational features of the area. Even the air in the ventilation system is treated with ozone to assure the elimination of all odor.

The digested sewage sludge will be hauled in an especially designed tank truck to the main city treatment plant site for disposal.

Clearwater's Marina Station is a progressive solution to a modern sewage treatment problem. It is a fine combination of modern planning and modern equipment.

The P.F.T. equipment at Marina Station includes: two 40′ Floating Covers, one P.F.T. Pearth Gas Recirculation Unit, two Liquidometer Position indicators with High and Low Level Alarms, two Supernatant Selectors and Gauges, one lot of Gas Safety Equipment, one #170 Heater and Heat Exchanger Unit.

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Exclusively since 1893

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Briefs

New Treatment Plant for Metropolitan London Water incorporates slow sand filtration, microstraining and chemical treatment together with gas turbine driven stand by generators is one of the largest and most modern in Europe—page 321.

Continuous Flow Meter Shop describes how one utility by applying industrial engineering practices increased production from their meter shop without increasing manpower or cost—page 324.

Sleeve and Thrust Bearings part 13 of the series on centrifugal pumps discusses lubrication, maintenance and the applicability of these bearings to pumps—page 330.

Relative Economy of Aeration Methods for Activated Sludge develops and compares costs for surface and diffused air methods. Utilization of new data on the surface method from England together with American results and costs has produced an unusual article—page 333.

Coagulants, their selection. Part II reviews the seven chemicals and their combinations used for Coagulation in water treatment—page 339.

A brief recounting of the necessary materials and their sources, essential to a successful public relations program for a sanitary district—page 342.

Valve Selection for Water and Sewage Service is a complex problem. For a thorough discussion of the factors involved see page 344.

The Use of Capacitors in Water & Sewage Plants—Part II demonstrates how to determine the capital investment required and the saving which would result from installations of capacitors in a typical situation—page 351.

Hydrolysis and Estimation of Phosphates is an item of increasing interest with present detergent usage. A revised method for determination of phosphate which resulted from an Ohio Health Department study is given on page 354.

Chlorination Control the sixth part concludes this series on chlorination with a discussion of the all important problem of applying the right amount of chlorine, at the proper time and being able to measure it —page 356.

Trench preparation and pipe bedding are the subjects covered in the second installment of the new series on construction supervision. Written from the practical viewpoint, this series is of usefulness to water and sewage works personnel who have responsibility for construction and major repair work.—page 362.

Penna. Section AWWA hears about the importance of Forestry in Water Supply and a new method for the determination of aluminum in water—page 366.

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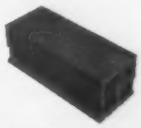

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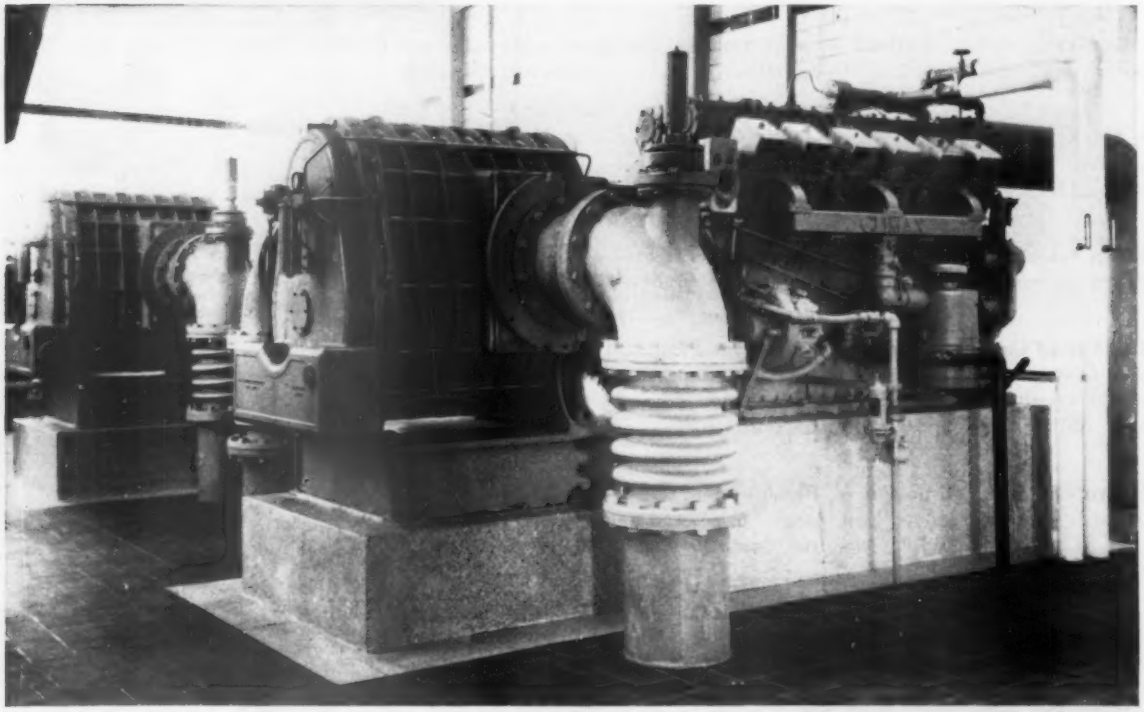
THE PROBLEM:

To obtain maximum aeration effectiveness, the delivery rate of air diffused into aeration tank liquor by individual air diffuser units *must remain as nearly constant as possible* over varying ranges of temperatures and pressures. Blowers must be compact, efficient, vibrationless, noiseless and capable of operation at high rates of speed.

THE ANSWER:

"CHICAGO" STANDARDAIRE BLOWERS

1. **Positive displacement** type of patented *axial flow* construction provides shock, pulsation-free operation.
2. **STANDARDAIRE** Blowers operate at high speed and can be advantageously direct-connected to an electric motor. Large size STANDARDAIRE Blowers operate at 1160 rpm; medium size at 1750 rpm; small size at 3500 rpm.
3. **STANDARDAIRE** Blowers provide *constant discharge* regardless of existing temperatures and pressures.
4. **STANDARDAIRE** Blowers are more compact . . . require smaller frame size motors . . . less floor space . . . smaller foundations . . . simplified piping . . . and cost less to install.



A typical "Chicago" STANDARDAIRE Blower installation at Benton Harbor, Michigan

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News—Here & There

AWWA 79th Convention—Awards and Entertainment

Starting off with a double feature of food and friendliness, San Francisco welcomed the AWWA with a lavish California Buffet on Sunday evening, July 12. Thus started four exciting days of technical meetings, entertainment, and good-fellowship.

Monday morning, July 13, saw the start of 15 technical sessions covering over 70 topics. Highlights of these technical sessions will be covered in the next two issues of WATER & SEWAGE WORKS.

Awards

At the annual Awards & President's Reception, held in the Gold Room, Fairmont Hotel on Monday July 13, the following awards were announced in addition to those published in the April issue of WATER & SEWAGE WORKS, in the report on AWWA Board Actions:

Association Directors

Leigh O. Gardner .....Arizona
Justin J. Davis Kentucky-Tennessee
Herschel O. Self .....Michigan
Georgia H. Beard .....Nebraska
Karl R. Kennison ....New England
J. M. Diven .....New York
Winston H. Berkeley
.....Pacific-Northwest
Samuel S. Baxter ....Pennsylvania

Wendell R. LaDue Safety Awards

Class 1
Jersey Shore (Pa.) Water Co., E. F. Jones, Pres.

Class 2
Monongahela Valley Water Corp. (Elizabeth, Pa.) Francis D. Donahue, Manager.

Class 3
San Diego (Calif.) Water Dept., Paul Beermann, Director.

Fuller Awardees

Charles M. Mathews
.....Alabama-Mississippi
George W. Marx .....Arizona
Lauren W. Grayson .....California
William T. Randall .....Canadian
Harry Bl Shaw .....Chesapeake
Gerald L. Davis .....Illinois
John E. Kleinhenz .....Indiana
Philip F. Morgan .....Iowa
Frank E. Willey .....Kansas
Harold Jernigan ..Kentucky-Tenn.
Herschel O. Self .....Michigan
Lindon J. Murphy .....Missouri
William A. Sommers ....Nebraska
William A. Healy ...New England
Harold M. Ohland ....New Jersey
James C. Harding .....New York
Stanford E. Harris .North Carolina
Harold H. Behlmer
(deceased) .....North Central
Claude V. Signor
.....Pacific-Northwest—1958
Erdman J. Allen
.....Pacific-Northwest—1959
Reginald B. Adams ...Pennsylvania
William Schirmer ....Southeastern
Fred H. Puckhaber .....Southwest
John P. Kavanagh .....Virginia
Preston A. Reynolds ....Wisconsin

The Cuban, Florida, Intermountain, Montana, Ohio, Rocky Mountain, and West Virginia Sections made no award for the Association Year 1958-59.

Entertainment

On Monday night after the Awards and President's Reception, dancing was enjoyed for the balance of the evening at the traditional President's Ball.

Tuesday night, July 14, was Fun Night. And, to assure a prompt start, the leading wineries of California had set up beautiful tasting tables to allow everyone to prove his abilities as a connoisseur. After this gastronomic delight, entertainment was provided by an all-star vaudeville show.

Wednesday night was a night on the town, with Fisherman's Wharf a favorite spot.

Many eulogies and tributes were presented to Harry Jordan at the banquet Thursday night, for his 23 years of accomplishment as Secretary of the Association. This was followed by the Annual Ball.

The ladies enjoyed a bus tour of the sights of San Francisco with a luncheon stop at Fisherman's Wharf, a luncheon and fashion show at the "Mark", and a tea-cake-and talk session on Thursday.

Water Utility Management Manual

The American Water Works Association, has just published a new Manual on Water Utility Management.

The 192-page volume is the first in a projected series of educational manuals being prepared under the direction of AWWA's Committee on Education. Although designed primarily as a text for management training courses, the Management Manual can also serve as a valuable guide for those already in managerial positions.

The 22 chapters cover such key topics as rate schedules, service regulations, legal responsibility, accounting, office operation, safety programs, and financing.

Known as AWWA M5, the Management Manual sells for $2.00 per copy (or $1.60 to members sending cash with order). For short-school or similar use, a quantity discount is offered on orders of 20 or more.

Address all inquiries and orders to:

American Water Works Association
2 Park Avenue,
New York, 16, N. Y.

Rice Joins Lancy Labs

Lancy Laboratories, Consultants, has announced the association of Robert L. Rice, P.E., as Vice President in charge of its Philadelphia office.

The research and development laboratory is located with the Pittsburgh office at Zelienople, Pa., under the direction of Dr. L. E. Lancy, President.

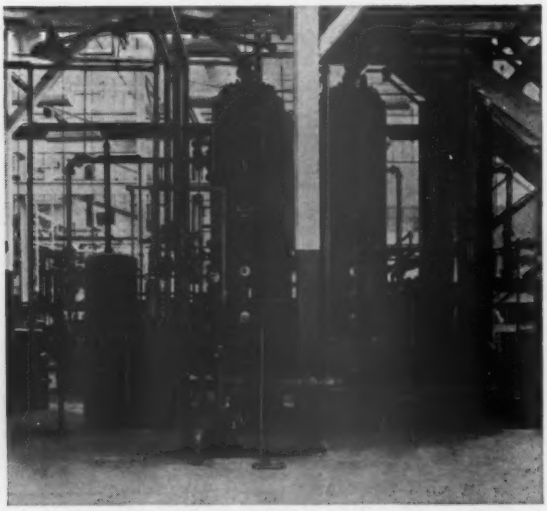
Mr. Rice was Director and Vice President of Fischer & Porter Co., prior to his affiliation with Lancy Labs.

CONTINUED ON PAGE 9A

FLUIDICS

is a Pfaudler Permutit program providing
the know-how
the equipment
and the experience
for solving problems involving fluids

FOR WASTE TREATMENT, the Fluidics program provides a wide range of specialized equipment and technical service to help you efficiently recover valuable materials and easily dispose of unwanted wastes.



Purification of liquids and recovery of dissolved minerals from plating solutions, pickling baths, textile wastes, process solutions and similar fluids are assured with unique effectiveness by Permutit Ion Exchangers. Recovery of valuable materials often pays for equipment within a short time.

Sludge blanket clarification of fluids requiring removal of suspended solids such as fly ash, precipitates, turbidity, etc. is accomplished with high efficiency by the Permutit Precipitator.

Dewatering Sludges. Titan Centrifuge exerts settling power up to 7800 times gravity. Concentrates slimes and clarifies liquids. Precisely separates two liquids and a solid in a single pass. Dewaters plating wastes, protein fines and flocculent precipitates. Recovers oil from tank bottoms, fat from waste, and pulp from white water. Saves product, filter aid, power and maintenance.

Flotation clarification of fluids containing fats, oils, greases, organics and colloidal suspensions is done quickly, effectively and economically with the Permutit Colloidair Separator.

Add to this equipment our Simplex meters and flow controllers, Permutit chemical feeders, filters and vacuum degasifiers, Ranarex CO_2 indicators and recorders, and Pfaudler evaporator systems, and you get an idea of the scope of this program in just the waste treatment area of fluid processing. Yet Fluidics is a program that provides more than just equipment. You can get complete engineering assistance as well as expert advice based upon more than 50 years' experience in fluid waste control.

For more information on how Fluidics can help in your waste treatment program, contact our Permutit Division, 50 West 44th Street, New York 36, N. Y.

In Canada: 207 Queen's Quay W., Toronto 1, Ontario.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS...the science of fluid processes

News—Here & There

CONTINUED FROM PAGE 7A

Addendum Page 354

Mr. Robert E. Shoup, author of the article "Hydrolysis and Estimation of Total Ortho-, Poly-, and Meta-Phosphates", starting on page 354, has advised that since the article was prepared that the Laboratory has obtained one of the lower priced photo-colorimeters, and the procedure proposed in the article has been adapted to it.

"With a photo-colorimeter using cells which hold more than 25 ml, and a light path of 22 mm, the procedure can be altered as follows:

Use 25 ml of sample containing not over 1.2 milligrams of PO_4, or an aliquot diluted to 25 ml.

Add 1.0 ml of 7/10 H_2SO_4 in Step #1, above.

Make up to 25 ml after Step #5.

Use 8 drops of 10 percent ammonium molybdate solution in Step #6.

Use 5 drops of 2.5 percent stannous chloride solution in Step #7.

Read in 30 minutes, against a curve, at a wavelength of 490 Millimicrons."

Rockwell Forms Governmental Relations Dept.

Rockwell Manufacturing Company has announced the formation of a new executive department—Governmental Relations—with the responsibility of keeping abreast of legislative, political and tax affairs in the United States and throughout the world.

I. C. Rowe, formerly corporate secretary has been named to direct the job. He joined Rockwell in 1941 as a tax account and became assistant secretary in 1948, and secretary since 1951.

Federal Funds for Reservoirs

The Soil Conservation Service recently stated that up to 50 percent federal participation could be made available for the enlarging of storage reservoirs. The participation would be on the basis that such work would benefit fish and wildlife resources. The financing, authorized by Public Law 865, known as the Sikes Bill, would also provide aid for other projects such as modification of existing reservoirs, marsh development and stream improvement on the same basis.

L. D. Betz Receives Max Hecht Award

L. Drew Betz, president and director of Betz Laboratories, was presented with the 6th Max Hecht Award at the Annual Meeting of the American Society for Testing Materials. The award was established in 1954 by ASTM Committee on Industrial Water in honor of its first chairman and is given in recognition of outstanding service to the committee in the advancement of its objective—the study of water as an engineering material.

Mr. Betz, has been a member of the ASTM since 1937. He has been a member of Committee D-19 on Industrial Water since 1942 and has represented D-19 on the Standard Methods Committee of the American Public Health Association. He also represented D-19 on the former Joint Committee on Boiler Feedwater Studies and is currently Vice-Chairman of the ASME research committee which replaced it. In addition, he represented Committee D-19 on the Federation of Sewage Works Associations Standards Methods Committee.

Michaels, of CB&I Awarded Doctorate Degree

Earnest E. Michaels, president of Chicago Bridge & Iron Co., was awarded an honorary Doctor of Engineering degree by South Dakota State College, Bookings, South Dakota.

Mr. Michaels was graduated from South Dakota State in 1920 with a B.S. degree in Civil Engineering. He received his master's degree from the University of Illinois in 1922.

President of Chicago Bridge & Iron Co. since 1956, and a director of the company since 1946, Mr. Michaels is also executive committee chairman and immediate past president of the Steel Plate Fabricators Association, and chairman of the Welding Research Council of the Engineering Foundation.

H. S. (Scotty) Morse Retires

At the annual stockholders meeting of the Indianapolis Water Company, Howard S. Morse, Chairman of the Board, announced his retirement as Chairman. He will remain as a member of the Board.

His announcement terminated 34 years of active duty with the company. Mr. Morse joined the company as Manager in May 1925, after 20 years of engineering and public service work, first on irrigation projects in Montana, North Dakota and Colorado; Then on sewerage and water supply projects in Louisville, Cincinnati, Detroit, and Akron.

In July 1938, he was named Vice-President and Manager. Ten years later, in March, 1948, he became Executive Vice-President. From January 1950, until a brief period of retirement beginning in July, 1951, he acted in a consulting capacity, retaining his direct association as a member of the Board.

In January, 1953, he returned to active duty as President. In April, 1956, he was elected Chairman of the Board, as position he held until his retirement.

Maximum Permissible Radioactivity in Air and Water

National Bureau of Standards, U. S. Dept. of Commerce has issued a revised Handbook containing the latest recommendations of the National Committee on Radiation Protection and Measurements concerning the maximum permissible internal exposure of the human body to radioisotopes.

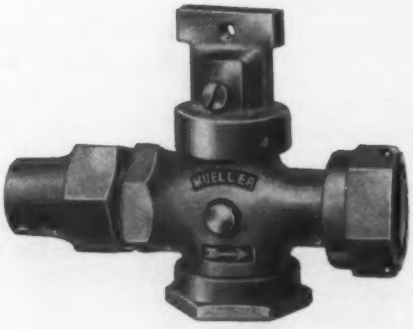
The present Handbook, revised from the 1953 issue, includes maximum permissible concentrations and body burdens for some 240 radioisotopes and includes many refinements based on knowledge not available in 1953. The study has included the evaluation of nearly 2000 separate researches reported in the literature, having bearing on the permissible dose problem.

The new values reflect, where applicable, the lowering of the basic maximum permissible dose recom-

CONTINUED ON PAGE 11A

For easy-to-make, leak-proof settings...

3 NEW MUELLER® meter stops!



H-14300 Inverted Key Meter Stop

"Service to meter" stop
Connects directly between service line and meter
Inlet connection for ¾" copper service pipe
Swivel nut outlet for ⅝" x ¾" or ¾" meter
Round way, inverted key curb stop design
Combined Cap and Tee Head with Check

H-14313 Inverted Key Meter Stop

"Meter to house" stop
Connects directly between meter and house piping
Swivel nut inlet, Inside I.P. outlet

Size of Stop	¾"	1"
Size Meter Spud thread	⅝" x ¾" or ¾"	1"
Size Stop outlet	¾"	1"

Round way, inverted key construction
Phosphor bronze spring in base for easy turning
Base cap sealed with "O" ring
Combined Cap and Lever Handle with Check

H-14325 Angle Meter Stop

"Service to meter" angle stop
Connects directly between vertical service line and meter
Provides elbow to set meter horizontally at any convenient height
Angle inlet connection for ¾" copper service pipe
Swivel nut outlet for ⅝" x ¾" or ¾" meter
Straight way, ground key construction
Solid Flat Head with Lock Wing

These special application meter stops are typical of the attention to detail in research, design and engineering that becomes a part of every Mueller product manufactured for the water industry. Write for complete information on the full line of Mueller meter stops and other meter setting equipment.

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Factories at: Decatur, Chattanooga, Los Angeles;
In Canada: Mueller, Limited, Sarnia, Ontario

News—Here & There

CONTINUED FROM PAGE 9A

mended by the NCRP in 1957 and 1958. As a result of all of these considerations, some values have been increased, some decreased, and others remain essentially the same.

California Legislature Approves Feather River Project

The $1.75 billion bond issue for the Feather River Project, was given final approval by the California Legislature for submission to the voters at the 1960 election.

This water development bond issue will finance a dam near Oreville, and a series of aqueducts fanning out from a distribution point in the Sacramento-San Joaquin Delta to the central coastal and southern areas of the state.

The measure also provides for use of $130 million of the bond money for loans and grants to local areas for water projects and $375 million from the California Water Fund (Tidelands oil royalties) and its accurals, or the bond money itself, for the development of additional water facilities and the protection of the Delta area.

In an earlier development, the legislature gave final passage to California's $11 billion, 100-year water plan which will serve as a guide for state development.

Harrington Joins C. I. Pipe Research

The Cast Iron Pipe Research Association has announced the appointment of Donald W. Harrington of Mount Morris, Michigan, as field representative.

Harrington's appointment was occasioned by an expansion of the association's technical advisory service to consulting engineers and water utility executives. He will make his headquarters in Atlanta, Ga., and will service seven southeastern states.

A graduate of University of Kentucky and Tri-State College of Engineering, Harrington has been a city manager where his duties included the operation of the water utility and a partner in firms specializing in underground construction for municipal utilities.

Engineering-Science Opens New Office and Forms New Division

Engineering-Science, Inc., consulting and research engineering firm has announced the opening of a San Francisco Bay area office and laboratory. The new office is located at 4144 Telegraph Ave., Oakland, and will include facilities for engineering design and for laboratory research, development, and analyses in the chemical biological, radiological and other fields.

Mr. Harvey Ludwig, President also announced the establishment of a new Division of Water Resources Development within the company. The new division will be centered at the Oakland office and will be headed by Mr. F. L. Hotes. Mr. Hotes, who was formerly Professor of Irrigation Engineering at the University of California has just completed an assignment as Chief of the Water Conservation Division in Iran for the Development and Resources Corp. of New York City.

Chicago Sanitary District To Build Zimmermann Process Plant

The Chicago Sanitary District has just authorized a $11,870,000 Contract with Sterling Drug Inc., to build the first Zimmermann process plant for the disposal of sewage sludge.

The contract provides that Sterling will design, engineer and build the plant, furnish and install all equipment, test its operation when completed and instruct the Sanitary District's personnel in operating it. The plant will have a capacity of 200 tons of sewage sludge solids per day and will represent more than 20 percent of the Sanitary District's total treatment capacity. It will consist of four units, each of 50 tons capacity and each having a full complement of equipment. In addition, one turbo-generator unit for developing power will be installed.

Sterling is scheduled to complete the plant and have it ready for testing, except for power generator equipment, within 18 months. The entire unit is scheduled for completion within 24 months. The contract also provides that Sterling will build additional Zimmermann Process units if requested by the Sanitary District.

Water Pollution Abatement Laws

The Manufacturing Chemists' Association has just published a compendium of state and federal water pollution abatement laws of the United States.

The 53 chapters of the compendium cover the laws of the fifty states, federal laws and those of the District of Columbia and Puerto Rico pertaining to water pollution.

One chapter is devoted to each state or jurisdiction. It describes the organization of the water pollution control commission or agency and gives its address; describes the commission's water pollution abatement policy, viges a resume of the law and briefly outlines the rules and regulations in force.

Copies of the Manual W-5, Compendium of Water Pollution Laws, are available at $5.00 each from the Manufacturing Chemists' Association, Inc., 1825 Connecticut Ave., N.W., Washington 9, D.C.

Polyethylene Pipe Standards

Commodity Standards Div., U.S. Dept. of Commerce has published a new edition of the Commercial Standard for Polyethylene pipe, designated Flexible Polyethylene Plastic Pipe, CS197-59.

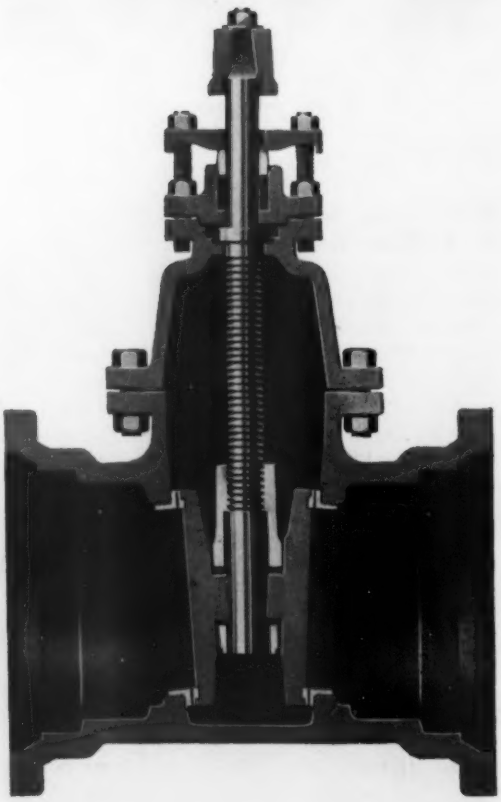
The new standard includes added tests, more informative marking, and provisions for more advanced methods of manufacture. The revised standard also covers requirements and tests for material, workmanship, dimensions, tolerances and weights, working pressure, field pressure, incremental pressure, sustained pressure, and evironmental cracking for pipe in three series of wall thicknesses. Pipe to be used for conveying potable water is required to meet specifications of the National Sanitation Foundation and carry the seal of approval, the "nSf" mark. A means is also provided for declaring compliance with the provisions of the Commercial Standard.

R.D. WOOD GATE VALVE

THE R. D. WOOD GATE VALVE...
DESIGNED TO BE
BURIED AND FORGOTTEN

- So simple and sturdy that it lasts for generations
- Always ready to operate when needed
- Only 3 moving parts—the spreader and two discs

Available with conventional or "O" ring packings



R. D. WOOD COMPANY

Public Ledger Building, Independence Square
Philadelphia 5, Pa.

Manufacturers of Mathews Hydrants and "Sand-Spun" Pipe
(centrifugally cast in sand molds)

Equipment News

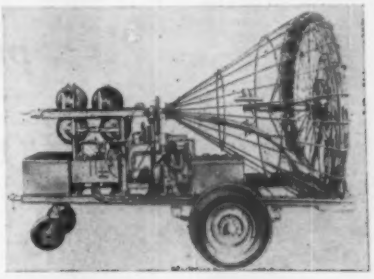
Sewer Cleaner

801

W. H. Stewart, Inc., Syracuse, N. Y., has developed the "Super Hydrodder" for sewer and conduit cleaning and maintenance.

The new unit has an exclusive hydraulic drive and positive pneumatic feed. With this new type of drive system, there is no wasted energy due to the very nature of a hydraulic system. If the "Push" or thrust of the tool is resisted by foreign matter, or debris, in the sewer or pipe, hydraulic power automatically increases the rotation of the reel, which causes the tool to rotate (or drill) faster. No manual adjustments are needed. When the resistance is overcome, the hydraulic force automatically re-distributes itself back to the forward thrust of the rods while still maintaining sufficient torque at all times. Torque may be increased instantly without shutting down the machine. Its hydraulic drive greatly cushions the shock to rods, tools and engine. Parts last longer.

With the positive pneumatic feed, the rods are practically "hand fed"



through the machine. Greater, surer thrust is assured because the rod, as it passes through the drive wheels, is in constant contact with pliable rubber. The pneumatic drive wheels firmly grip every inch of rod at any given speed. The "Super Hydrodder" will accept any size rod, any length rod . . . or continuous rod.

14 Inch and 16 Inch Asbestos-Cement Pipe

802

Keasbey & Mattison Company, Ambler, Penna., has announced the availability of its asbestos-cement pipe in 14 in. and 16 in. diameters for use in pressure installations, gravity sewer lines as well as irrigation systems.

K&M 14 in. and 16 in. pressure pipe is manufactured in classes 100, 150 and 200 to conform to AWWA, ASTM and Federal Specifications. For use in sewers, the new diameters will be available in five crushing strengths intended to meet a variety of field conditions.

The pipe will be furnished in standard 13-foot lengths and special short lengths; 6 ft 6 in. and 3 ft 3 in. It is designed for use with K&M's exclusive patented Fluid-Tite Coupling.

Plastic Coated Valves

803

DeZurik Corporation, Sartell, Minnesota, has announced that DeZurik Eccentric Valves are now avail-

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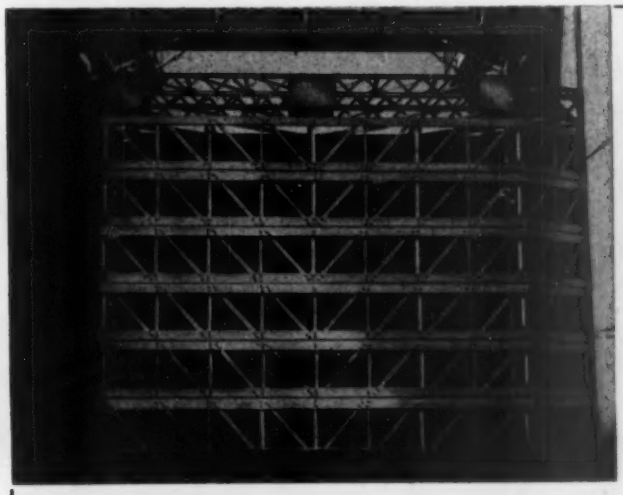


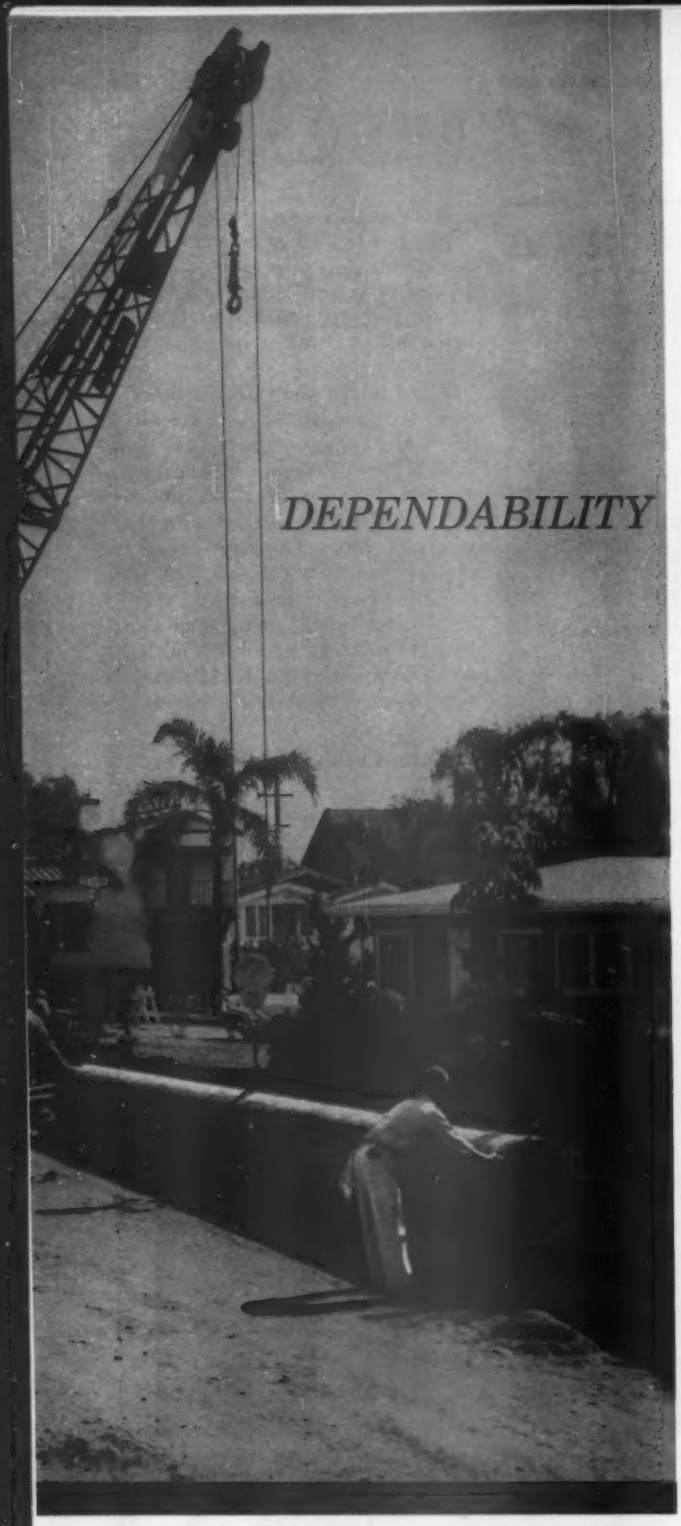
FROM BIG 38 FT. ALUMINUM FLOOD GATE TO SMALL STOP PLATE

No matter what your water and sewage equipment need . . . Washington Aluminum is your answer

Engineers who want to reduce installation costs and corrosion problems specify Washington Aluminum maintenance-free equipment. Washington Aluminum proven-in-use design and fabrication products makes this name a mark of distinction on every installation.

Among Washington Aluminum products are: Non-skid walkways, Sluice gates, Ladders, Aeration trays, Suspension bridges, Manhole covers—and all types of custom-fabricated products. If it should be aluminum . . . it should be made by Washington Aluminum.

WASHINGTON ALUMINUM COMPANY, INC., Dept. 78
BALTIMORE 29, MARYLAND



AMERICAN CONCRETE CYLINDER PIPE *provides...*

DEPENDABILITY with ECONOMY

This pretensioned concrete cylinder pipe embodies all of the qualities and characteristics sought by water works engineers for permanent water supply and transmission lines—strength, sustained high carrying capacity; trouble free service and unusually long life. Its competitive initial cost has made it possible for hundreds of water works agencies throughout the West to obtain these desired qualities for pipelines with pressures generally ranging from 100 psi upward, and requiring diameters of 10" through 60" (or in many cases larger, where specific project conditions permit). When you select pressure pipe for your permanent water "growth lines," be sure to investigate American Concrete Cylinder Pipe, a superior product with an outstanding record of acceptance.

A. The steel cylinder provides a positive water seal or membrane as well as part of the total steel area required for internal stresses.

B. The smooth centrifugally applied mortar lining of a nominal ¾" thickness provides positive internal protection, sustained hydraulic capacity, and, **imparts rigidity and strength through "arching effect."**

C. Steel reinforcement rods, which together with the steel cylinder provide the total cross-sectional steel area required for the operating pressure specified, are wound under controlled tension and accurate spacing around the concrete lined cylinder, placing it under moderate compression.

D. In conjunction with the steel rod reinforcement along the entire surface of the cylinder, the application of a dense concrete coating produces, in effect, a **reinforced jacket** which affords additional structural strength as well as positive exterior protection.

The 32-foot long pipe sections are easily installed with standard equipment using a single cable sling. In addition to providing a watertight seal, the rubber gasketed joint facilitates ease and economy of installation, and eliminates the need for caulking or field welding.

American PIPE AND CONSTRUCTION CO.

LOS ANGELES: 4635 Firestone Blvd., South Gate, Calif.—LOrain 4-2511
HAYWARD: P. O. Box 630 — JEfferson 7-2072
SAN DIEGO: P. O. Box 13 — CYpress 6-6166
PORTLAND: 518 N. E. Columbia Blvd.— BUtler 5-2531
ALBUQUERQUE: P. O. Box 1782 — CHapel 7-0486
PHOENIX: American Concrete Pipe Co. (Subsidiary)
P.O. Box 12127 — Alpine 2-7566

CONCRETE PIPE FOR MAIN WATER SUPPLY LINES. STORM AND SANITARY SEWERS. SUBAQUEOUS LINES

Equipment News

CONTINUED FROM PAGE 13A

able with plastic coatings. The coatings greatly improve the corrosion resistance of a cast iron valve at only a slight increase in price, the company stated.

The plastic coatings make the valve especially suitable for neutral salt solutions, alkalies, alkaline salts, mild acids and many other services. They are also an economical answer to iron contamination in water distillation, demineralization and deionization systems.

DeZurik Valves work on a unique eccentric principle which pivots the plug eccentrically in the valve body to match an eccentrically-raised seat. The plug touches the valve body only when the valve is closed. Plug friction is completely eliminated. Their resilient faced plug eliminates the need for lubrication to achieve tight shut off.

Fluoride Reagent

804

Fisher Scientific Co., Pittsburgh, Pa., has developed a reagent designed specifically for the rapid (15-to-30 minute), sensitive, colorimetric micro-determination of fluorides.

With Fisher Certified Lanthanum Chloranilate, fluoride is measured directly. The reaction, which liberates

CONTINUED ON PAGE 17A

Fast new 350 BANTAMS

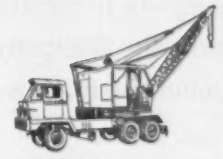
. . . with hydraulic bucket action speed up your digging and profits!

Here's America's newest trenching advancement that's letter-perfect for water and sewer contractors—new BANTAM Series 350 with optional hydraulically actuated back hoe bucket. This combination gives you tremendous new speed and digging advantages in your work—enabling you to bid lower and get more jobs . . . make more money from every job.

The hydraulically actuated BANTAM back hoe is a feature easily added to any BANTAM 350 with standard or long-boom back hoe models. The carrier mounted T-350 digs to 17'7", the crawler model to 18'10". Simply operated, it gives giant breakout action (20,000 lbs.) at the bucket teeth to speed you through tough, rocky and frozen digging conditions—provides precision ditching with intricate control for stepped-up operations in all line and intersection work. In addition, you get all the benefits of America's newest shovel-crane design: more rapid work cycles with increased line pulls . . . famed BANTAM sure-footed stability with high flotation in both carrier and crawler models . . . greater work capacity . . . simpler, completely foolproof mechanical controls.

With the T-350 BANTAM you have your choice of four BANTAM-built carriers for exactly what your price and work call for . . . the choice of standard or long side frames in the crawler model C-350. Two-speed, independent travel and in-cab digging lock are standard on the BANTAM crawler.

Try a new BANTAM . . . see how you can get your work speed and profits up to all-time highs. Call your BANTAM distributor or mail coupon.



BANTAM T-350
11-ton capacity

BANTAM CR-350
self-propelled
11-ton capacity

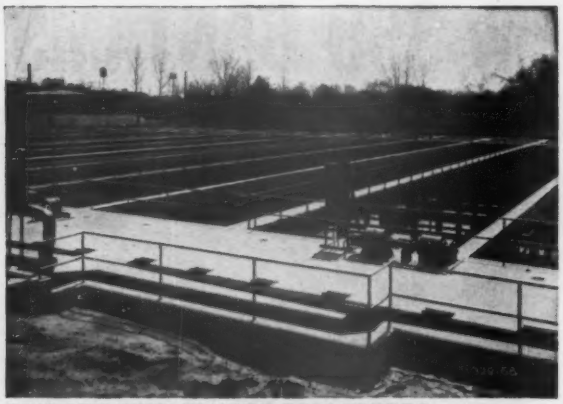
World's largest producer of truck crane-excavators

SCHIELD Bantam Co.

Schield Bantam Co. WS-238
303 Park Street, Waverly, Iowa

Please send me information on BANTAM ☐ C-350 crawler, ☐ T-350 carrier models. ☐ Include information on new hydraulically actuated back hoe. ☐ Also details on BANTAM self-propelled CR-350.

Name_____
Title_____
Company_____
Address_____
City_____ Zone_____ State_____



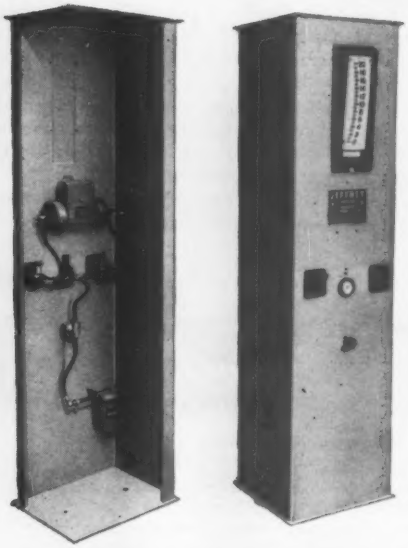
PRIMARY TYPE SLUDGE COLLECTORS

V-BUCKET GRIT COLLECTORS

CONVEYORS FOR LIME

VERTICAL BACK-CLEANED SCREEN

Specify dependability with **JEFFREY** equipment



DIFFERENTIAL CONTROL *with visual "loss-of-head" gage for automatic sewage screen operation*

SHOWN here are some of the many types of equipment produced by Jeffrey for sewage treatment plants. Jeffrey offers *dependability*—proved by years of experience in large and small plants. Jeffrey engineers can help you in application of this equipment for efficient results. For complete information, write The Jeffrey Manufacturing Company, 996 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT... TRANSMISSION MACHINERY... CONTRACT MANUFACTURING

Equipment News

CONTINUED FROM PAGE 15A

chloranilate ion in direct proportion to the amount of fluoride ion reacting, proceeds quantitatively.

Fisher Certified Lanthanum Chloranilate, analyzed by Fisher analysts for sensitivity to fluorides, is a stable powder. The user adds it directly to a buffered solution (usually pH 6.5) containing the fluoride. The resultant chloranilate ion, directly proportional to the amount of fluoride ion, is determined colorimetrically with such instruments as the Fisher Electrophotometer or the Beckman DU, DK-2 and B, and the Spectronic 20 spectro-photometers.

pH Test Papers

805

R. P. Cargille Laboratories, Inc., New York, N. Y., has developed a new Test Paper, Hydrion Lo-Buff 5-9, that provides a new order of sensitivity in pH test papers.

Heretofore an appreciable amount of buffer was required for Test Papers to indicate pH of aqueous solutions. This new Test Paper readily shows differences in pH between tap water and distilled water. It is recommended for use in the control of all treatment of water and for checking the pH of water used in fisheries, swimming pools and for all purposes

where the water contains a very small amount of buffering agent.

The range of this Test Paper is pH 5.0 to 9.0 and the color chart shows the colors indicated by steps of 0.5 pH unit. Sample color chart will be sent

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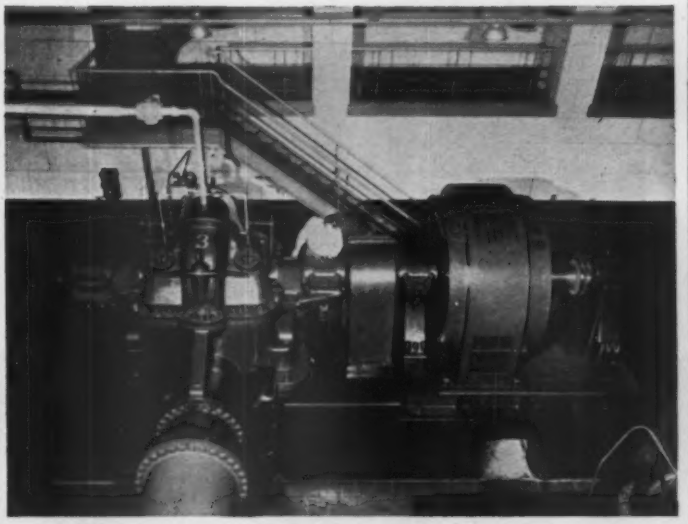
A case for F-M Split-Case Centrifugals!



Typical installation in Toledo averages 80.314% wire-to-water efficiency for year!

Exceptionally high and dependable efficiency with steady, low-cost operation year after year—that's the report from a host of municipalities and industries using Fairbanks-Morse pumps in their pumping stations.

Why? Ask stations like Collins Park High Service in Toledo, O., where five Fairbanks-Morse 36-in. Split-Case Centrifugal Pumps have been giving superb performance for 17 years. The No. 3 pump in the photo pumped 6,065,590,000 gallons in one year alone, handling 26.13 percent of the plant total, and consuming just 3.55 kilowatts hours per million foot gallons!

Your Fairbanks-Morse Field Engineer welcomes you to inspect many other reports like this from his files—reports revealing why no other manufacturer can match the experience of Fairbanks-Morse in providing pumps and drivers for both municipality and industry. Your F-M Field Engineer will be glad to work with your own engineers in selecting the best equipment for your specific requirements. Write Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.

See Sweet's Product Design Catalog File for complete F-M Pump Line.

FAIRBANKS-MORSE
a name worth remembering when you want the BEST

PUMPS • SCALES • ELECTRIC MOTORS • DIESEL, DUAL FUEL AND GAS ENGINES
LOCOMOTIVES • COMPRESSORS • GENERATORS • MAGNETOS • HOME WATER SYSTEMS

"Backwashing simple, uniform and infrequent . . . ALOXITE® porous plates have operated 9 years without attention"

—says Mr. J. E. HOLZER

Supervisor Water Treatment and Storage Division, City of Rock Island, shown (right) below with Mr. Keith Pfaff, Water Treatment Operator.

The Water Works of the City of Rock Island handles Mississippi River water and serves a population of 52,000 over a 10½ sq. mile area. Demand varies from 6½ to 10½ MGD. Nine years ago the plant was remodeled by Greeley and Hansen Engineers, Chicago and ALOXITE aluminum oxide underdrain plates installed with anthracite filter media in 10 units, each 20′ x 30′.

"These plates have eliminated mudballs, which were previously a problem," says Mr. Holzer." Backwashing is infrequent and easy—we get an even wash on the entire surface, with no high spots. We use a minimum of water and of course there's no pulling down of the filter beds to clean them. The ALOXITE plates have cut downtime almost in half. We expect to add six more filters and these also will be ALOXITE-equipped."

Superintendent of Public Works for the City of Rock Island is Mr. Earl T. Miller

CARBORUNDUM

Registered Trade Mark

Dept. X-89, Refractories Division, Perth Amboy, N. J.

Equipment News

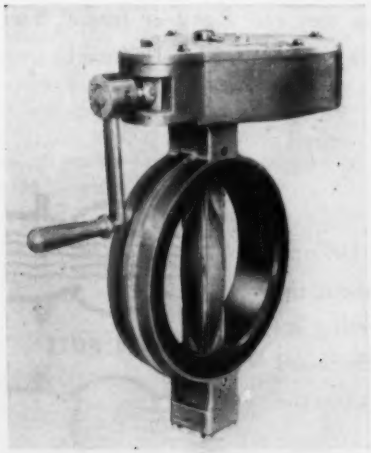
CONTINUED FROM PAGE 17A

on request. This Test Paper is furnished in rolls ⅜ inch wide x 180 inches long, sufficient for over 200 tests.

Butterfly Valves

806

Henry Pratt Company, Chicago, Ill., has announced a new concept in rubber seat butterfly valves. This new line of valves will bring a substantial improvement in economy to



the high quality, high pressure rubber seat butterfly valve. The Monoflange Mark II will feature numerous technical innovations and is being offered for 150 psi tight shutoff in sizes 4" thru 20". A wide range of material trim and valve actuators for manual or automatic operation are available.

Rotary Pipe Cutter

807

Reed Manufacturing Co., Erie, Pa., has developed a line of new rotary four-wheel pipe cutters designed for large steel and cast iron pipe from 12" to 24" diameters.

The new device consists of a separable circular frame joined at the mid-sections by hinged screws and adjusting nuts. An aluminum handle is placed successively over the eight lugs on the outside of the frame and the same handle is used to tighten the cutter as cutting proceeds.

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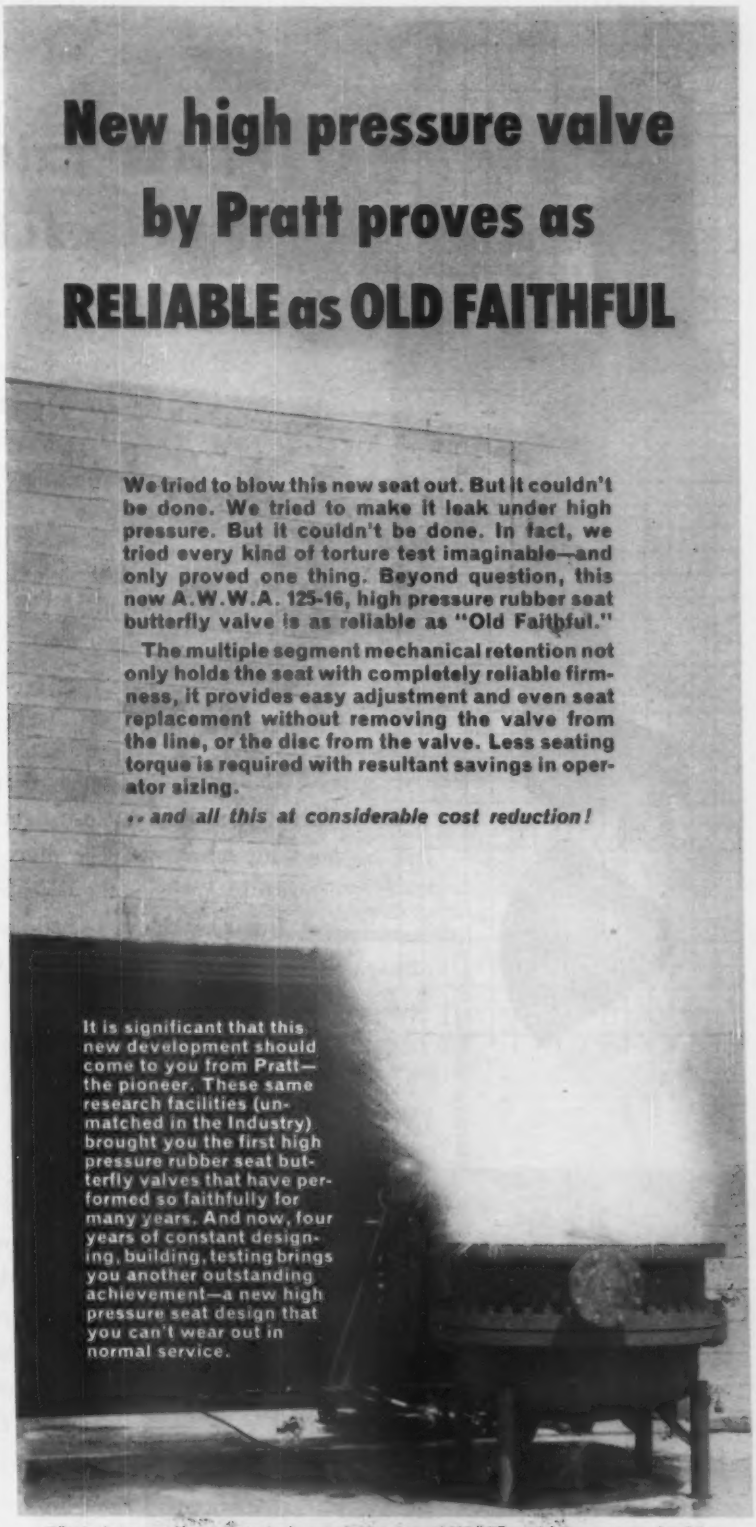

New high pressure valve by Pratt proves as RELIABLE as OLD FAITHFUL
We tried to blow this new seat out. But it couldn't be done. We tried to make it leak under high pressure. But it couldn't be done. In fact, we tried every kind of torture test imaginable—and only proved one thing. Beyond question, this new A.W.W.A. 125-16, high pressure rubber seat butterfly valve is as reliable as "Old Faithful."
The multiple segment mechanical retention not only holds the seat with completely reliable firmness, it provides easy adjustment and even seat replacement without removing the valve from the line, or the disc from the valve. Less seating torque is required with resultant savings in operator sizing.
.. and all this at considerable cost reduction!
It is significant that this new development should come to you from Pratt—the pioneer. These same research facilities (unmatched in the Industry) brought you the first high pressure rubber seat butterfly valves that have performed so faithfully for many years. And now, four years of constant designing, building, testing brings you another outstanding achievement—a new high pressure seat design that you can't wear out in normal service.

48" valve being tested for seat retention by snapping disc open with 150 # differential pressure across closed disc.

Creative Engineering for Fluid Systems

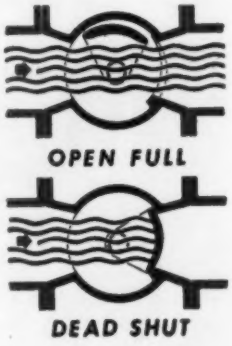
HENRY PRATT® RUBBER SEAT Butterfly Valves

Henry Pratt Company, 319 W. Van Buren St., Chicago, Ill. • Representatives in principal cities

This plug makes the difference !

And the difference is DeZurik! For *only* DeZurik Valves utilize this resilient-faced plug—combined with Eccentric Action—to provide tight shut-off and easy operation on any line. Abrasives in the flow can't damage it—solids in the line can't prevent tight shut-off. And the single-face construction will not trap liquids in the valve where they can digest or freeze! You get this difference with DeZurik . . . and ONLY DeZurik!

With exclusive Eccentric Action, DeZurik Valves open easily, close tight without the need for lubricants. The plug, pivoting eccentrically, matches the eccentrically-raised seat. It touches the valve body *only* when the valve is closed; there's no friction, no scoring, no binding!



DeZurik Valves are available in sizes ½" thru 20", in many body materials, and with a complete range of remote operators. See the DeZurik representative in your area, or write for more details.

The wide acceptance of DeZurik Valves in plants throughout the country is further indication of their positive performance, their complete dependability, their longer life! Plant personnel and Consulting Engineers agree: The DeZurik difference is a BIG one!

DeZURIK CORPORATION
SARTELL, MINNESOTA

Equipment News

CONTINUED FROM PAGE 19A

The new cutter is said to be especially suited to pipeline maintenance and repair. The 16" size weighs only 51 pounds complete and all of the units separate into three easily carried parts. A minimum of digging is required since the four-wheel design requires no more than 45° to 60° of handle swing, and only a six to eight inch channel is needed under the pipe.

A patented pipe guide automatically aligns the cutter for a right angle cut and the hinged adjusting screw permits the cutting wheels to adapt to out-of-round pipe without loss of cutting efficiency. Patented pins enable the specially designed cutting wheels for steel or cast iron pipe to be quickly interchanged.

Since the cutter is manually operated, it requires no power source and creates no explosion or electrical hazards, even when used in mud or water.

Parshall Flume Flow Transmitter

808

Builders-Providence Div., B-I-F Industries, Inc., Providence, R.I., recently announced a new in-stream type Chronoflo Transmitter for the Water and Sewage Industries. Installed on Parshall Flumes, wiers or other head-area devices for measuring

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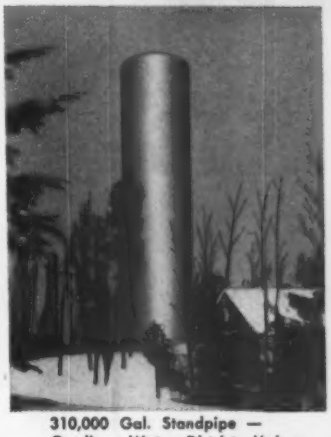
KING
PAINT MAKERS SINCE 1834

The SYMBOL OF AUTHORITY IN COATINGS SYSTEMS for POTABLE WATER STORAGE UNITS



310,000 Gal. Standpipe — Gardiner Water District, Maine

250,000 Gal. Elevated Tank, Holden, Mass.

Two of the many hundreds of installations using KING Coatings — INSIDE and OUT . . .

KING TANK COATINGS are unique because

1. They are integrated systems — not merely coats of paint.
2. They were formulated specially and exclusively for potable water storage tanks and are not offered for sale for any purpose other than tank work.

FOR INTERIOR SURFACES

KING TRIPLE LEADKOTE (basic lead silico-chromate) or ZDO-120 (Zinc dust-zinc oxide) systems offer defense against corrosion, defense in formulation against improper application.

FOR EXTERIOR SURFACES

KING METAL COATERS offer color-fast weather and corrosion resistant protection in 3 Soft Grays and 2 Greens and Lettering Black, as well as Aviation White and International Orange for F.A.A. checkerboard patterns. TANK COATER ALUMINUM provides a truly streakless aluminum finish combining heavy pigmentation with a low-acid vehicle for maximum durable brightness.

Send for Bulletin 57070, a comprehensive 7 page booklet giving full analytical and application specifications on KING TANK COATINGS SYSTEMS. This is not a sales brochure, but a strictly technical work.

KING DIVISION THE WILBUR & WILLIAMS CO., INC.
Factory and General Offices
662 Pleasant St., Norwood, Mass.

Gentlemen:

Please send Bulletin 57070 to:

Name .....

Title .....

Company .....

Address .....

City ..... Zone ..... State .....

In BUENA VISTA, VIRGINIA

TYLOX®

Rubber
PIPE GASKETS

- √ REDUCE PIPE-LAYING COSTS
- √ MAKE WATER-TIGHT JOINTS
- √ WHIP ACID ATTACK

Coupling TYLOX-Gasketed pipe is as fast as the few seconds required to shove pipe home into the line. Mud and water, as shown here does not slow up the work, or affect the compression seal.

Here's how . . .

TYLOX Gaskets "snap on" to pipe tongues in seconds . . . merely shoving the pipe home completes the joint. Being *flexible*, TYLOX compensates for pipe angularities, mud and water doesn't slow up coupling work, and laid line can be backfilled immediately. Construction costs are substantially reduced.

TYLOX Gaskets have seven sealing ribs that "pack" the annular space tight as pipe is coupled. A true *compression*, yet flexible seal is formed which prevents leakage of water *in* or *out* of the joints. Natural resilience of the TYLOX rubber keeps the seal water-tight. Root and sediment problems are prevented, and sewage treatment costs are reduced.

TYLOX Gaskets are made of rubber specially compounded for immunity to sewage and industrial waste acids and alkalies. Under ground and under compression, they outlast the life of the pipe itself.

SEND FOR ENGINEERING DATA AND ILLUSTRATED CASE HISTORIES ON TYLOX RUBBER PIPE GASKETS

* **PROJECT:** City of Buena Vista, Va., trunk line to sewage treatment plant.

ENGINEERS: R. Stuart Royer & Associates, Richmond, Va.

CONTRACTOR: English Construction Co., Alta Vista, Va.

PIPE: TYLOX-coupled T & G in 15" to 24" diameters, manufactured by Roanoke Concrete Products Co., Inc., Roanoke, Va.

5123

HAMILTON KENT MANUFACTURING COMPANY

KENT, OHIO

427 West Grant Street Orchard 3-9555

CANADIAN: 10 Brussels St., New Toronto, Ontario, Phone: CLifford 1-2494

Equipment News

CONTINUED FROM PAGE 21A

rates of flow of water or sewage in open channels, the new transmitter is in-stream actuated. It utilizes a unique in-stream type of float arrangement with the 6" expanded polystyrene float riding directly in the channel at the proper metering location. Because the float motion is vertical, no radial correction is required.

The new Builders-Providence Chronoflo Flow Transmitter eliminates the stilling well, saving on its construction and maintanance. It also eliminates the need for flushing systems, float well cover, connecting piping, sediment tanks, blow-down valves and frequent cleaning.

Manhole Meter

809

Sparling Meter Co., El Monte, Calif., has developed a Saddle Meter that permits it to be installed quickly and easily on steel cylinder or reinforced concrete pipe in sizes from 16" to 72".

The assembly slides directly through the opening of the pipe's standard flanged section or manhole opening and bolts easily into position ready for immediate service. The meter is the propeller type and may be installed at any convenient angle in a full flowing suction or discharge line. Total flow is registered on a 6 digit straight reading totalizer, reading in standard units. Accuracy is within 2% over the manufacturer's specified range.

CONTINUED ON PAGE 25A

Engineering PLUS...

Keeps Tank Interiors Corrosion Free at a Practical Cost

One of the five municipal tanks serving the City of Jacksonville, Fla. which has been cathodically protected by E.R.P. system since 1942.

The City of Jacksonville, Fla. has relied on engineering plus from Electro Rust-Proofing Corp. since 1942 to protect water storage tanks serving the city. Since installation of cathodic protection, tanks have been virtually corrosion free on the under water surfaces and maintenance costs have been reduced to a minimum.

E.R.P. engineering plus means cathodic protection systems
designed to meet your needs...
maintained to your benefit...
priced to your profit...

E.R.P. provides engineering plus to meet any corrosion problem of submerged or buried metals. For full information on cathodic protection for your water storage tanks, water treatment structures and pipelines, write for bulletin E-42.94.

E.R.P. CATHODIC PROTECTION SINCE 1935

ELECTRO RUST-PROOFING CORP.
A SUBSIDIARY OF WALLACE & TIERNAN INC.
30 MAIN STREET, BELLEVILLE 9, NEW JERSEY
CABLE: ELECTRO, NEWARK, N. J.

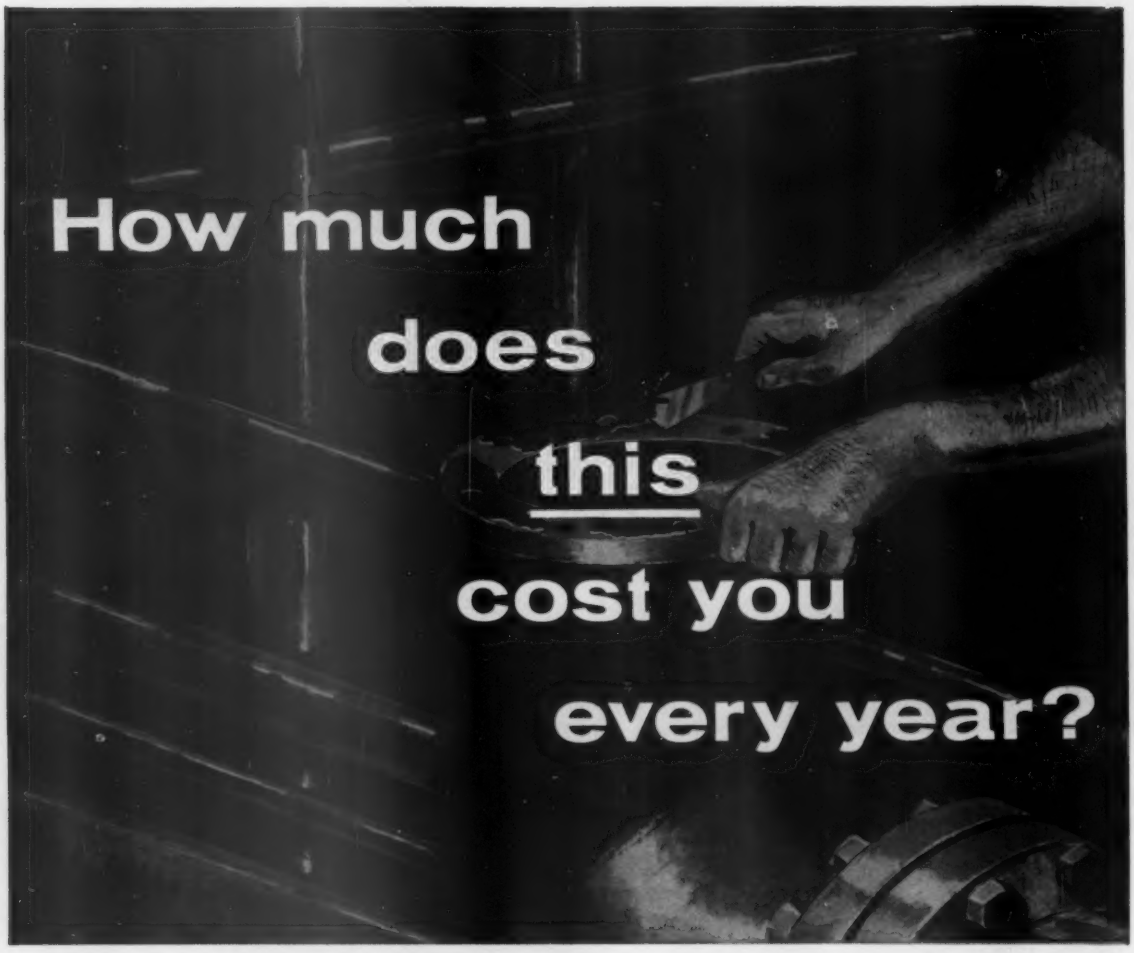
IF IT'S **FREE FLOWING AND DRY**

we have accurate reliable means of feeding it. For information about these dry chemical feeders *both gravimetric and volumetric...*

Write Dept. M-42.94

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

Maintenance Cost Too High?



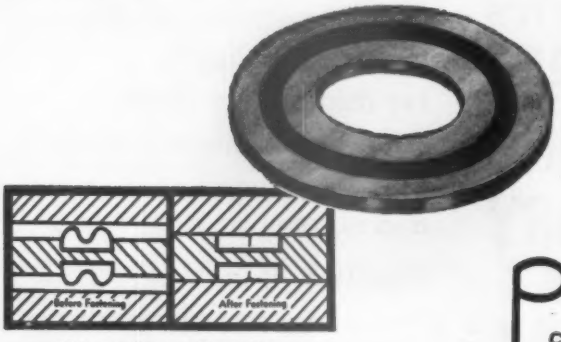
How much time, effort, and money is spent cleaning, resurfacing and/or replacing flanges to replace the seal!

Expensive? Yes!

Why not find out about Gask-O-Seals and save! Here are the facts: With Gask-O-Seal, flange faces require little or no cleaning or resurfacing of flanges when replacing the seal — *and Gask-O-Seals are re-usable.*

Gask-O-Seals save money and effort in many other ways, too. They are visually inspectable, do not need to be re-torqued, there is no material creep and they are non-directional, non-flexible, easy to install. They provide no-leakage sealing, *can not blow out,* and there is no wear due to pulse.

Now available to fit ASA standard flanges. Write for free catalog.



Note metal to metal contact.

Parker SEAL COMPANY

CULVER CITY, CALIFORNIA and CLEVELAND, OHIO

A DIVISION OF PARKER-HANNIFIN CORPORATION

Equipment News

CONTINUED FROM PAGE 23A

In addition to its ease of installation on existing concrete pipe, a fabricated steel saddle and mounting skirt may be furnished to customer specifications for mounting on reinforced concrete or steel pipe at the time the pipe is being manufactured.

The meter comes complete with saddle, gaskets, bolts and straightening vanes; or meterhead only with gasket and bolts.

Heavy Duty Submersible Pumps

B10

Goulds Pumps, Inc., Seneca Falls, New York, has introduced a new series of heavy duty submersible pumps constructed of corrosion resistant bronze or stainless steel for use in wells having a diameter of six inches or more. Their rugged construction actually makes them easy to dismantle for field service.

The UB series is currently available in 13 sizes, from 1-½ through 10 H.P. for well depths to 1000 feet and for capacities up to 77 gpm. Single phase units 1-½ through 5 H.P. and 3 phase units in all sizes.

The O-ring poppet type check valve retains water in piping when the pump is idle. An easily removed companion flange and check valve facilitates checking the rotation without dismantling the pump.

QUICK, economical, durable repairs for tile with D-J MORTAR

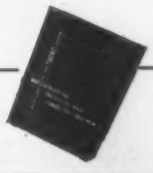
Nonmetalic, No Oxidation, No Unsightly Stains . . . .

Loose mortar has been removed. D-J Mortar is simply brushed over entire ceramic tile wall, filling all voids, shrinkage cracks, etc.

While D-J Mortar is still damp, excess is wiped off tile surface, leaving all joints, cracks and holes completely repointed.

A costly time consuming repointing job has been reduced to the economy and speed of a single brush coat!

Just off the press, write for our New 20 page brochure



Standard Dry Wall Products Inc.

BOX X, NEW EAGLE, PA.

Now Available – Crane A.W.W.A. Valves with "Ring-Tite"* and "Fluid-Tite"** Ends

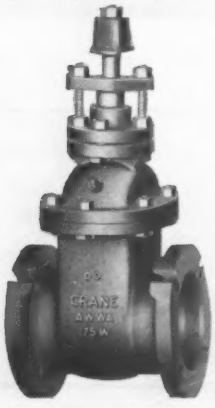
Two new Crane A.W.W.A. valves for use with asbestos-cement pipe —"Ring-Tite" and "Fluid-Tite"—are available in 3, 4, 6, 8, 10 and 12-inch sizes. These valves—added to Crane hub, flanged and mechanical joint end patterns—enable you to specify Crane quality for most A.W.W.A. valve installations.

More Advantages in Crane Quality

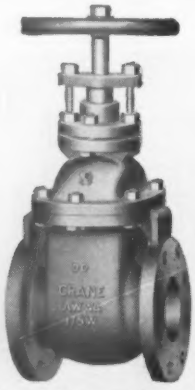
You can put Crane A.W.W.A. valves into service with no question of operating dependability when needed. They're engineered to give long-term trouble-free, maintenance-free service. Here are some of their advantages:

1. **Simple, 4-piece disc assembly and guide rib design—can't jam or become disengaged in service.**
2. **Trunnion-mounted rotating discs move freely . . . prevent wear on disc and seat.**
3. **Positive wedging action seats discs tightly**
4. **Non-binding ball-type gland and gland flange**
5. **Meet A.W.W.A. standard specifications**
6. **All patterns available either bronze-trimmed or with all-bronze internal parts with "Ni-Vee"‡ bronze stems**
7. **Choice of two types of stuffing boxes—with "O" ring seals or conventional packing**

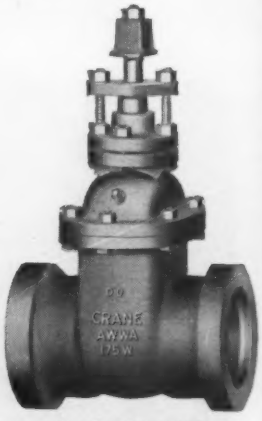
For complete details, ask your Crane Representative for information, or write to the address below.



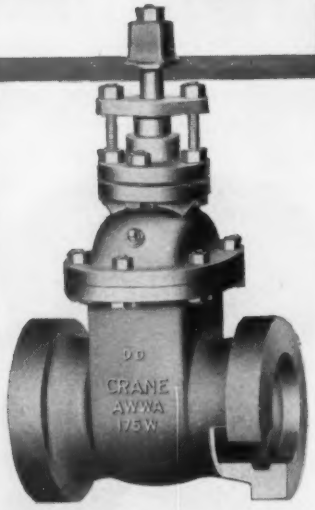
No. 2487½ Mechanical Joint Ends
Sizes†: 2 to 24-inch



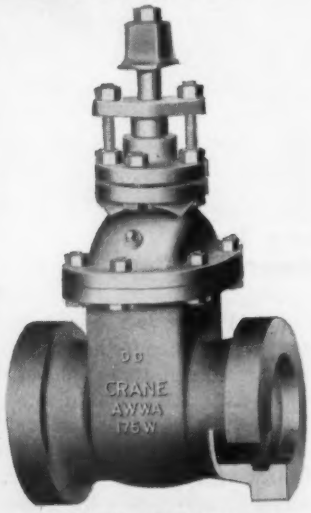
No. 2485 Flanged Ends
Sizes†: 2 to 24-inch



No. 480½ Hub Ends
Sizes†: 2 to 24-inch



No. 2482½ "Fluid-Tite" Ends—
Sizes: 3, 4, 6, 8, 10, 12-inch



No. 2482½ "Ring-Tite" Ends—
Sizes: 3, 4, 6, 8, 10, 12-inch

**Johns-Manville Asbestos Pipe*
***Keasbey-Mattison Asbestos Pipe*
† Excludes 5-inch size
‡"Ni-Vee" is a registered trade-mark of the International Nickel Co.

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill.—Branches and Wholesalers Serving All Areas

News of Suppliers

Griffin Wheel Forms Pipe Division

The Griffin Wheel Company, Chicago, Ill., a subsidiary of the American Steel Foundries, announced the formation of a new division, the Griffin Pressure Pipe Division, which will produce and sell centrifugally cast pressure pipe used for the transmission of water, gas and oil. Goff Smith, Pres. of Griffin, said that it is anticipated production of pressure pipe will start early in 1960 at its Council Bluffs, Iowa Plant.

The new division will be headed by S. C. Prest, Vice President and General Manager. Initial annual plant capacity will be 40,000 tons of pipe, and approximately 75 people will be employed, most of whom will be recruited from the Council Bluffs area.

Griffin has been a manufacturer of cast iron freight car wheels for eighty years, and during the past five years has built five new plants which produce cast steel wheels for the railroad industry in the United States and Canada.

Chicago Bridge Enters Saline Water Conversion Field

Chicago Bridge & Iron Company, Chicago, and G. & J. Weir limited of Glasgow, Scotland have announced the formation of Wier-Chicago Bridge, a jointly owned subsidiary company, which will design, fabricate and erect saline water conversion plants. The company will combine the experience of G & J. Wier, a leader in large salt water evaporators, with the fabrication and construction facilities of CB&I.

Weir-Chicago Bridge will be headed by William Vandersteel, resident manager of G & J. Weir's New York office. Executive offices of the new company will be at 50 Broad Street, New York 4, N. Y. Sales in the United States will be handled through this office and by Chicago Bridge & Iron Company's 17 district offices.

The Weir Group is the leading builder of large sea water evaporating plants. "Weirwater" plants totaling 12,000,000 gallons per day supply more than two-thirds of the total installed world capacity. Currently under construction are a 40-stage "Multiflash" plant for the Island of Guernsey, and two 1,2000,000 gallon flash evaporators for the Sheikdom of Kuwait. The latter will be the largest individual units ever built.

DuHamel, Jr. Elected V.P. of Centriline

N. Young DuHamel, Jr. has been elected vice president of sales and advertising for Centriline Corporation, a wholly owned subsidiary of Raymond International, Inc.

Mr. DuHamel joined Centriline in 1951 as a field superintendent in charge of pipeline processing, and was transferred to the company's sales department in 1954.

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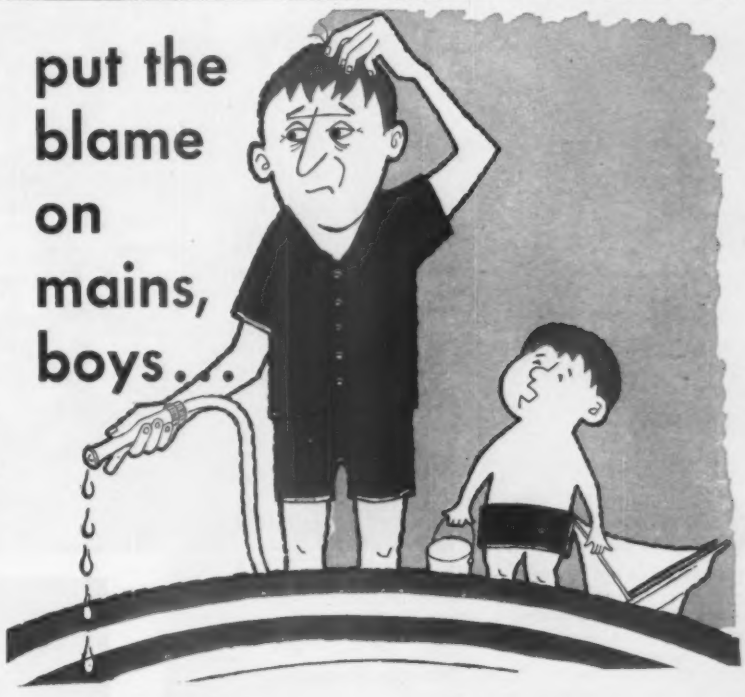


Did you hear a lot of customer complaints about low water pressure last summer? After the spring's heavy rains which filled reservoirs to the brim all over the country, *there should be no water shortage.* The problem probably rests underground . . . mains and distribution grids choked by pressure-killing tuberculation and corrosion.

There's one sure cure for your pressure problem . . . the Centriline Process. Centrilining permanently increases carrying capacities in all sizes of pipe by eliminating tuberculation and corrosion forever. After loose scale and tubercules are removed from the pipe, the Centriline machine applies a smooth, uniform coating of cement-mortar to the pipe wall by centrifugal force. Fast and economical, Centrilining is accomplished with a minimum of interruption to surface traffic, since the pipes are lined in place and excavations are not required at laterals and services.

With the introduction this year of the new, small diameter Centriline machine, you can permanently protect all water lines from 4 to 144 inches in diameter. Send today for our new brochure which fully describes the Centriline Process.

CENTRILINE CORPORATION

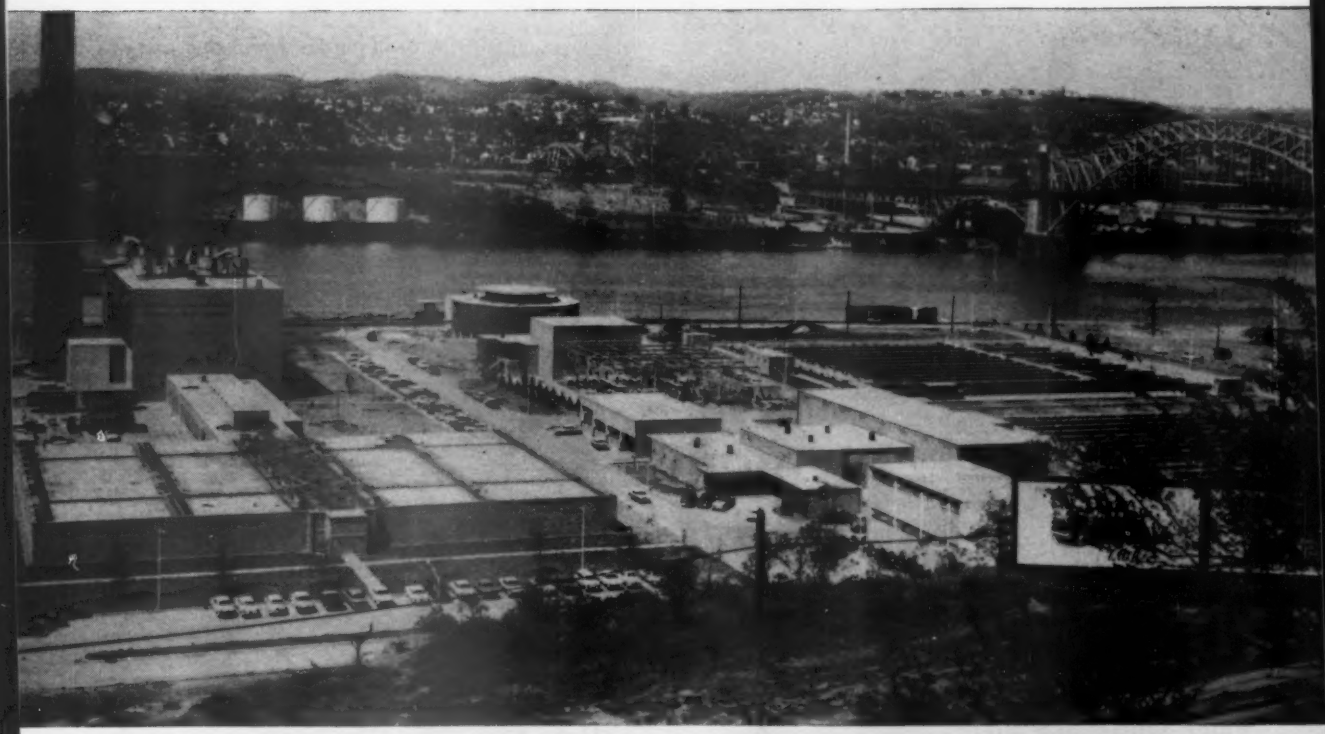
A Subsidiary of Raymond International Inc.

140 Cedar Street
New York 6, N. Y.
WOrth 2-1429

Branch Offices in Principal Cities of the United States, Canada and Latin America.

For the entire city of Pittsburgh and 69 surrounding communities . . .

4-D Wrought Iron Pipe handles corrosive wastes



Pittsburgh Sewage Treatment Plant
Joint venture of Allegheny County Sanitary Authority Engineers and Metcalf and Eddy, Consulting Engineers, Boston, Massachusetts.
Installation: Wayne Crouse, Inc., Pittsburgh, Piping and Equipment
Sauer, Inc., Pittsburgh, Plumbing
Layne—New York Co., Inc., Pittsburgh, Downshafts
Architect: Celli-Flynn, McKeesport, Pennsylvania

Final welding on downshafts—Welders here complete transformation of ¾-inch 4-D Wrought Iron plates into 31-inch O.D. pipe. 4-D's self-fluxing action enables welders to easily produce sound, durable welds by any of the accepted welding methods. Elasticity of 4-D Wrought Iron prevents cracking during soil shifts or sudden jars in hauling.

Spray piping for sludge tank—Strung horizontally throughout nine sludge tanks are 270 lengths of 2-inch corrosion-resistant 4-D Wrought Iron Pipe. Spray nozzles, installed one foot apart, are tapped into each pipe run. Nozzles are set on 20-degree angles and aimed parallel to the sloped flush-down weirs.

in new Pittsburgh Sewage Treatment Plant

The new $80 million intercepting sewer and sewage treatment project in the Greater Pittsburgh area is about ready for business.

Built by the Allegheny County Sanitary Authority, the modern system will minimize sewage problems for 69 communities in the Pittsburgh district. The plant will handle 150 million gallons of raw sewage each day. This in turn will greatly reduce pollution in many parts of the Allegheny, Monongahela and Ohio rivers.

4-D WROUGHT IRON IN ALL THESE SERVICES

Hundreds of tons of corrosion-resistant 4-D Wrought Iron are involved in the processing of raw sewage at the new plant. Piping in sludge concentration tanks, chimney vents, tank car connectors and vertical downshafts, as well as force main, effluent, liquid chlorine, compressed air, waste, vent and conduit lines are all 4-D Wrought Iron.

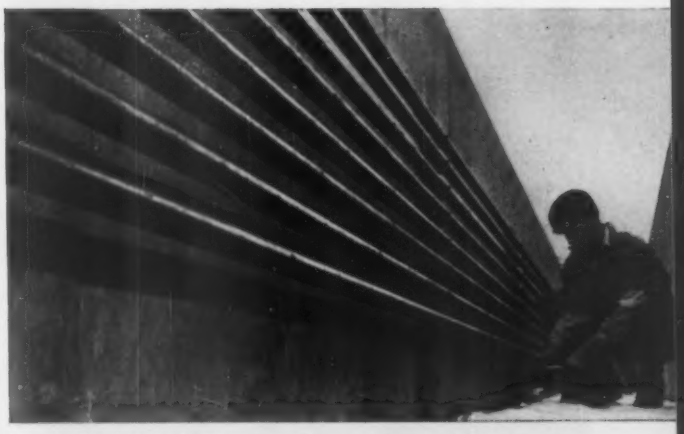
Diameter of the 4-D Wrought Iron Piping ranges from 1-inch to 36-inch O.D.

HERE'S WHY THEY USED 4-D WROUGHT IRON

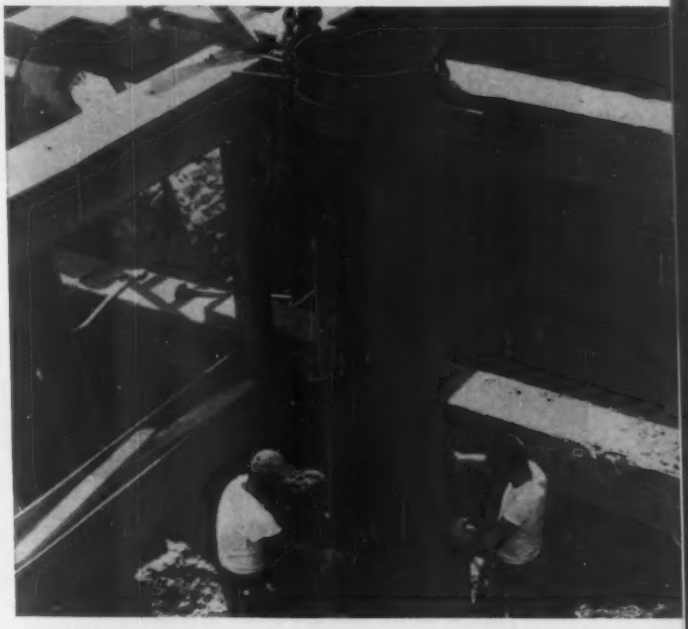
Wrought Iron's record of trouble-free service in demanding applications is well established. 4-D does its own job. Rarely needs costly protective coatings and wrappings. Successfully resists shock and vibration. Inherent elasticity prevents cracking. Long random lengths are available. So, fewer joints are required. Fewer hangers are needed. And 4-D Wrought Iron Pipe does not rely on excessive wall thicknesses to ward off corrosion.

SUMMING UP

Low cost per year of service is the sum and substance of these 4-D virtues. 4-D Wrought Iron lasts. Write for our booklet on sewage treatment and disposal installation. A. M. Byers Co., Clark Bldg., Pittsburgh 22, Pa.



Aligning liquid chlorine lines—One-inch diameter extra-heavy 4-D Wrought Iron Pipe, leading to plant's chlorine room, receives proper alignment prior to final inspection. A service as corrosive as chlorine piping calls for the piping longevity of 4-D Wrought Iron.



Coffin for corrosion—This 25-inch diameter 4-D Wrought Iron downshaft (¾" wall) spells doom for aggressive elements contained in corrosive raw sewage. 4-D Wrought Iron's unique composition of glasslike iron silicate fibers entrained in pure base metal, blocks corrosion as soon as it starts.

BYERS 4-D WROUGHT IRON

TUBULAR AND FLAT ROLLED PRODUCTS

Corrosion costs you more than Wrought Iron

CAST IRON PIPE WINS THE VOTE

Recently a questionnaire was mailed to water utility managers all over the U. S. One question asked was: *What kind of pipe do you prefer and why?* With 42 states heard from, the vote is overwhelmingly in favor of cast iron! Here are typical comments:

"Cast iron pipe has been in use for 200 years, and the record speaks for itself. All the other types have their use, but we would not recommend them in a well-built, expanding water works distribution system or large transmission lines."

—Illinois

"1. Cast iron pipe is permanent—long life. 2. Lined pipe cuts down complaints of 'red' or 'rusty' water. 3. Mechanical joints are time and labor-saving over other types of joints, and are more flexible."

—Iowa

"Long life has been proven. I have personally observed pieces cut out of existing systems which were laid prior to the turn of the century. Such observations indicated the pipe to be as good as the day it was laid."

—Kansas

HANDS DOWN!

"We are located in a limestone area. We find cast iron pipe will absorb more rock damage than any other pipe. We also use cement lined pipe to overcome our corrosion condition which exists in our water."

—Pennsylvania

"It is very easy and fast to lay, and you can swing the joint enough in places where you can save time and money."

—New Jersey

Three reasons why cast iron pipe is America's greatest water carrier:

1. More miles of underground cast iron water mains are now in use than of all other kinds of pipe combined.
2. More miles of cast iron water mains are now being purchased and laid than of any other kind of pipe.
3. Impartial surveys prove that today's water utility officials and consulting engineers prefer cast iron pipe for underground water distribution by an overwhelming majority.

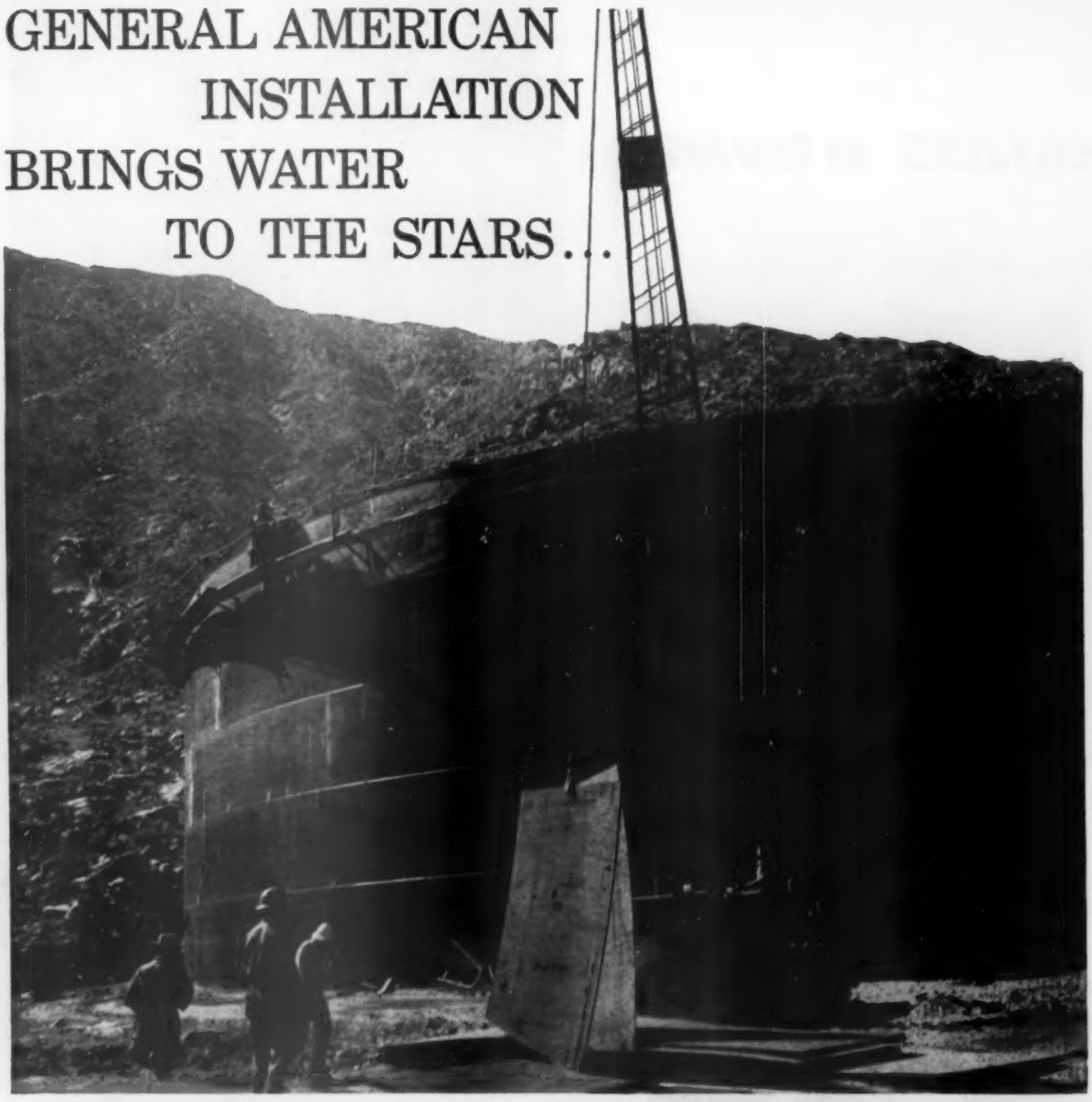
. . . good reasons for you to choose

CAST IRON PIPE

THE MARK OF THE 100-YEAR PIPE

Write for complete information to Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 3440 Prudential Plaza, Chicago 1, Ill.

GENERAL AMERICAN INSTALLATION BRINGS WATER TO THE STARS...



Palm Springs is a thirsty city. In this desert playground of movie stars and sun-worshippers at the foot of water-rich Mt. San Jacinto are more gardens and swimming pools per capita than any other place in the world. Within the mountain are many underground streams. The problem was to tap the resources and store more water than existing reservoirs would hold. The answer—a 5,000,000 gallon tank fabricated in General American's shops, trucked to a hard-to-reach spot on the hillside and erected by a General American field crew.

General American won this contract because of ability to fabricate the tank and erect it despite difficulties of terrain. Shops at many locations and strategically-based field erection crews make it possible for General American to do the job efficiently in any part of the country.

We would like to discuss your water storage problems, so why not write or phone the nearest General American office. You'll find *it pays to plan with General American.*

Only STEEL — Tanks are built to AWWA SPECIFICATIONS

Plate and Welding Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street • Chicago 90, Illinois

Offices in principal cities

PLATE & WELDING DIVISION — GENERAL AMERICAN — TRADE MARK

News of Suppliers

CONTINUED FROM PAGE 27A

Mr. DuHamel has a bachelor's degree in mathematics from Yale University. He is married and lives at 45 Erwin Park Road, Montclair, N. J.

Sammons Gen. Sls. Mgr. for B-I-F

B-I-F Industries, Inc., Providence, R. I., has announced the appointment of William L. Sammons as General Sales Manager.

In his new assignment, Mr. Sammons heads a highly qualified team of field sales and service engineers located in major business centers throughout the U. S. and Canada under Douglas Taber, assistant vice president. He also directs four groups of process systems engineers in Providence headed by Milford E. Rogers as manager of Utilities Sales; Paul A. Coffman, manager of Industrial Sales, Rudy P. Lowe, manager of Petroleum and Petro-Chemical Sales; and Charles G. Haire, manager of National Accounts.

Eimco Appoints Teletzke Div. San. Engr. Research

The Eimco Corporation, Salt Lake City, Utah, has announced the appointment of Gerald H. Teletzke to the post of Director of Sanitary Engineering Research.

Teletzke will work directly with Don Dahlstrom, Eimco' Director of Research & Development, with headquarters at Palatine, Ill. Teletzke comes to the Eimco organization from Purdue University, where he was Assistant and Associate Professor of Sanitary Engineering. Prior to this, he was instructor in Civil Engineering at the University of Wisconsin. He holds a M.S. in Civil Engineering and a Ph. D. from the latter school.

ONLY FROM KUHNS

DUCTILE

IRON PIPE FITTINGS

Kuhns long lasting ductile iron pipe fittings for high strength and corrosion resistance are pressure rated by Underwriters' Laboratories, Inc. Most types and sizes are stocked for prompt delivery, along with our complete line of high quality cast and malleable iron fittings. Write for catalog today.

THE KUHNS BROTHERS CO.

1800 McCall St. • Dayton, Ohio

OVER 3,000 SHAPES AND SIZES

K&M ASBESTOS-CEMENT SEWER PIPE

PERMANENTLY

Sewer pipe maintenance headaches disappear when you install "K&M" Asbestos-Cement Sewer Pipe.

Flow-stopping, pipe-clogging roots . . . no matter how cobwebby-thin . . . can't penetrate the exclusive patented "K&M" FLUID-TITE coupling . . . unmatched in its tight sealing. In repeated tests, "K&M" Asbestos-Cement Sewer Pipe successfully resisted infiltration even when external water pressure was 25 psi . . . the equivalent of a 58-foot head and way above field conditions.

Service remains continuous and uninterrupted . . . with fewer inspections and periodic cleanings. You can reduce treatment loads and costs . . . because infiltration is eliminated. Being made of quality asbestos fibers and portland cement, "K&M" Sewer Pipe does not corrode and is immune to electrolysis.

In fact, "K&M" Asbestos-Cement Sewer Pipe is a tax-saver at every stage of construction: planning and installation, as well as maintenance. Transportation and handling is less expensive, because "K&M" Asbestos-Cement Sewer Pipe is light in weight.

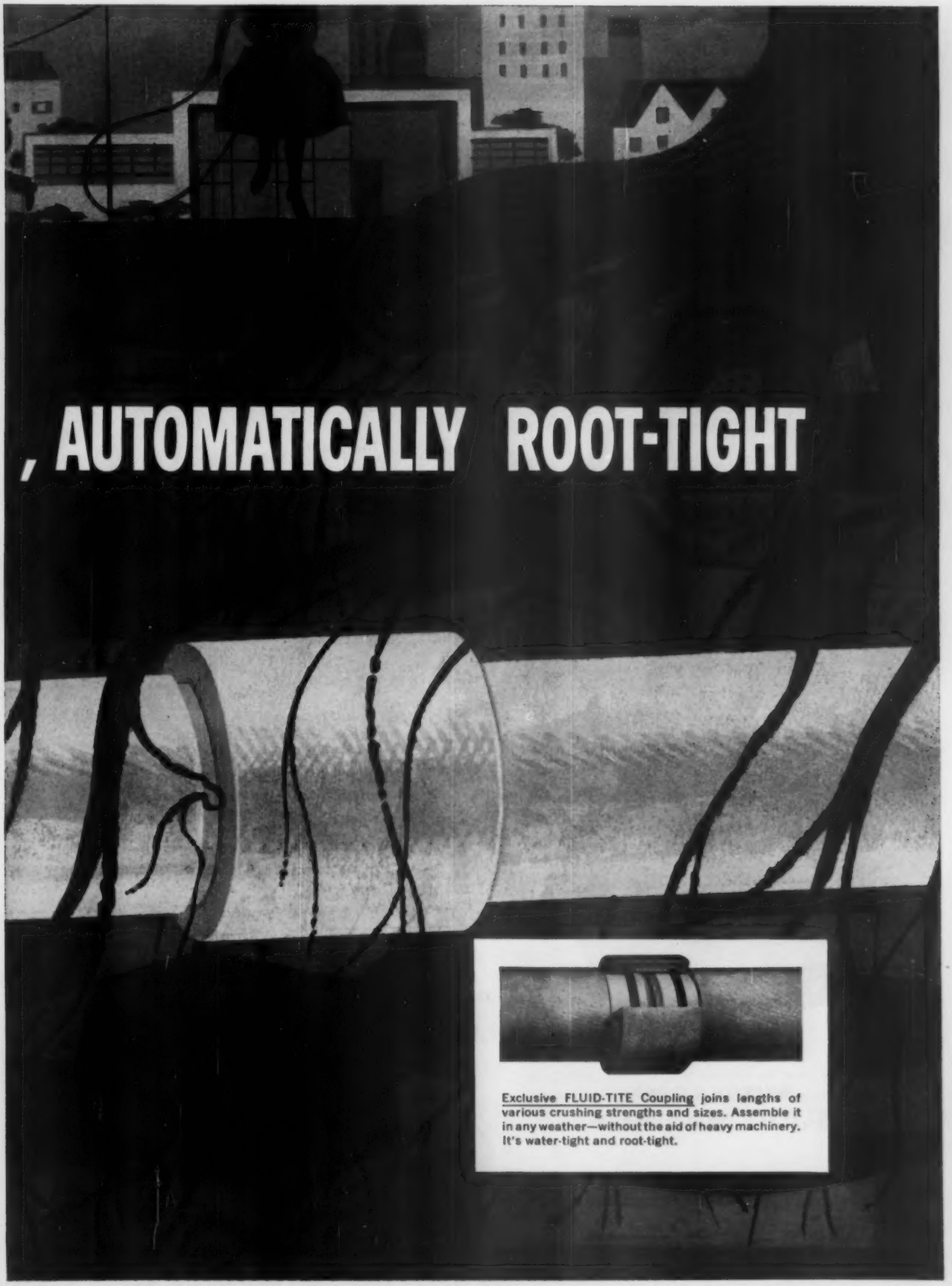
In short, practically indestructible materials plus eighty-five years of asbestos engineering give you the finest, most dependable sewer pipe available. That's why we urge you to write today for more information.

5 CRUSHING STRENGTHS OF K & M SEWER PIPE

Size Inches	Class 1500	Class 2400	Class 3300	Class 4000	Class 5000
6	1500	2400	3300		
8	1500	2400	3300		
10	1500	2400	3300	4000	5000
12	1500	2400	3300	4000	5000
14	1500	2400	3300	4000	5000
16	1500	2400	3300	4000	5000

K·M
BEST IN ASBESTOS

KEASBEY & MATTISON
Company • Ambler • Pennsylvania


, AUTOMATICALLY ROOT-TIGHT
Exclusive FLUID-TITE Coupling joins lengths of various crushing strengths and sizes. Assemble it in any weather—without the aid of heavy machinery. It's water-tight and root-tight.

Absolute Rigidity Means

...longer tool life

...perfect connections

Rigidity on the main...

Widely spread chain hook washers of the new B-100 are deeply recessed in yoke—cannot slip off when used on large diameter pipe. Unique design of chain hook keeps chain from twisting while tightening. They all add up to absolute rigidity on the main—machine cannot move during drilling, tapping or inserting operations. Broken tools and leaky connections are eliminated.

Rigidity in the boring bar...

Three widely spaced boring bar bearings, two in the feed sleeve and one at extreme bottom of boring bar, assure perfect boring bar alignment. Molded nylon lower bearing supports drill when it first contacts the main. Pipe curvature cannot deflect drill—tools give longer effective life. These three boring bar bearings guarantee perfect centering of tool and stop, assuring a pressure-tight connection.

These are only a few of the many advanced features of the new Mueller B-100 Drilling, Tapping and Inserting Machine. They are typical, however, of the attention to detail in research, design and engineering that become a part of every Mueller product used by the water industry.

MUELLER®
B-100 Machine

MUELLER CO. Since 1857 SERVING the Water and Gas Industries QUALITY

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles
In Canada: Mueller, Limited, Sarnia, Ontario

Cleans up to 120 feet of sludge bed per hour

Mechanical cleaner provides faster and more efficient sludge removal than conventional hand cleaning methods

Here's a mechanized method of cleaning sludge beds that will pay for itself in a relatively short time. While individual savings depend on such variables as size of plant, available manpower, method of disposal, etc., annual savings of 60% have been reported over conventional hand cleaning.

The sludge bed cleaner offered by Link-Belt is essentially a conveyor system on wheels . . . the system is mounted on a standard tractor, which travels on concrete runways in sand beds and cleans a path up to 26 feet in width. Performance-proven Link-Belt conveying and power transmission components are combined into an efficient mechanism that is operated by hydraulic motors.

The cleaning cycle works like this. Forked scoops assure minimum loss of filter bed sand. The scoops are raised alternately, elevating the sludge and chuting it over a front truss. Sludge is conveyed by two wing conveyors into a trough where it is pushed along by a center longitudinal flight conveyor. This conveyor carries the sludge up a 45° incline where it is deposited in a truck that is towed or driven behind the tractor.

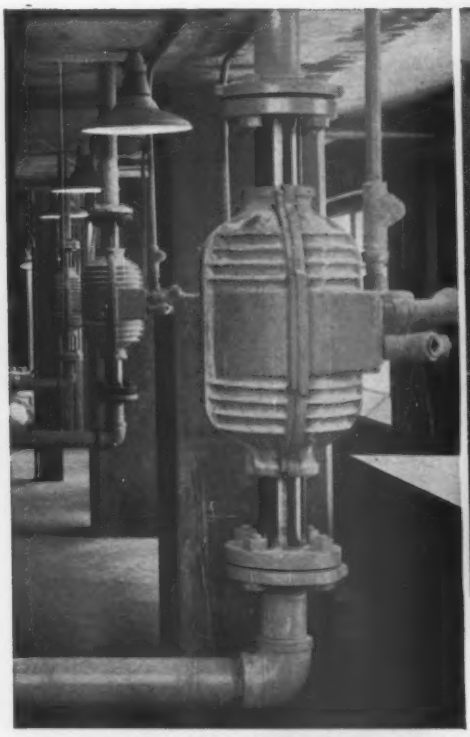
For more detailed information on how you can clean sludge beds faster, more efficiently, call your nearest Link-Belt office. Send for Folder No. 2671.

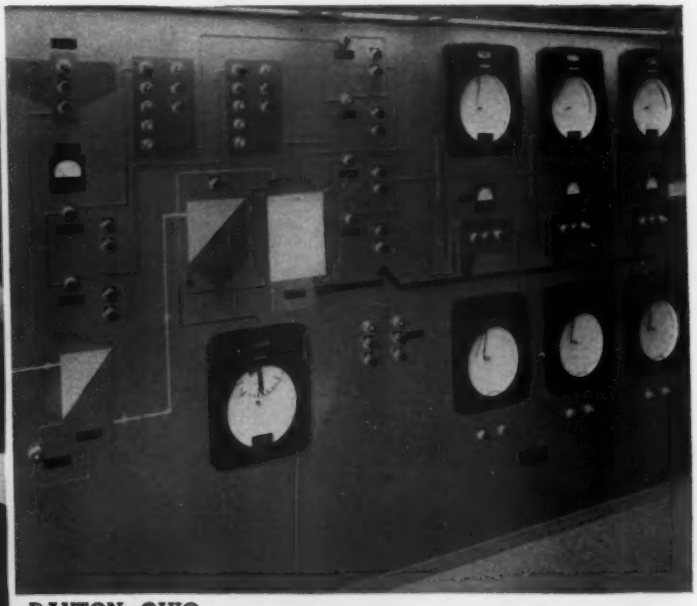
LINK-BELT

SANITARY ENGINEERING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. Sanitary Engineering Regional Offices—Colmar, Pa., Chicago 9, Kansas City 8, Mo., San Francisco 24. Sales Offices in All Principal Cities. Export Office, New York 7. Representatives Throughout the World. 14.802

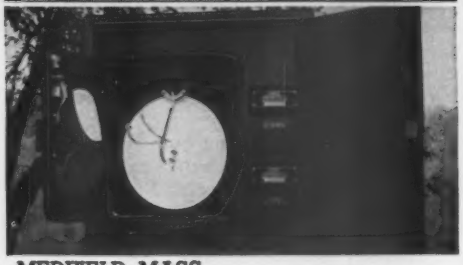
Line Restriction





DAYTON, OHIO

Three Foxboro Magnetic Flow Meters measure flow of sludge to centrifuges at Dayton's Lime Recalcining Plant. Designed around these meters, plant actually recovers up to 20% more lime than originally added to water. Graphic control panel in Feed End Building operates entire plant.

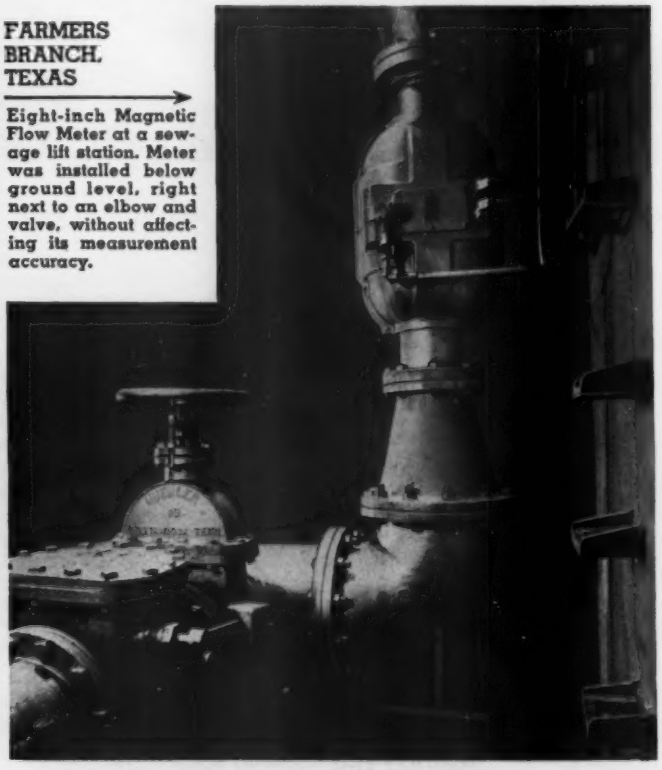


MEDFIELD, MASS.

Town of Medfield and nearby State Hospital have independent water supplies – use common storage facilities. Foxboro Magnetic Meter measures and records flow rates in both directions. Two integrators, next to recorder, keep separate running totals of both flow rates.

FARMERS BRANCH, TEXAS

Eight-inch Magnetic Flow Meter at a sewage lift station. Meter was installed below ground level, right next to an elbow and valve, without affecting its measurement accuracy.



Problems Eliminated!

for these municipal utilities equipped with Foxboro Magnetic Flow Meters

Introduced five years ago, the Foxboro Magnetic Flow Meter has proved its superiority for measuring water, sewage, sludge and other treatment plant flows.

Foxboro Magnetic Meters are installed the same as a length of pipe. Measurement is linear and is transmitted by electric cable to centrally-located Dynalog* Flow Recorders. There are no line restrictions of any type. That means no added pressure drop . . . no meter runs or straightening vanes.

Maintenance on the Magnetic Flow Meter is practically nil. There are no pressure taps to get plugged or frozen. There are no seals or purges . . . no moving parts to foul.

Look over the installations on these pages. And for complete details write for Bulletin 20-14C. The **Foxboro Company, 898 Neponset Ave., Foxboro, Mass., U.S.A.**

*Reg. U. S. Pat. Off.

Other Progressive Communities Installing Foxboro Magnetic Flow Meters

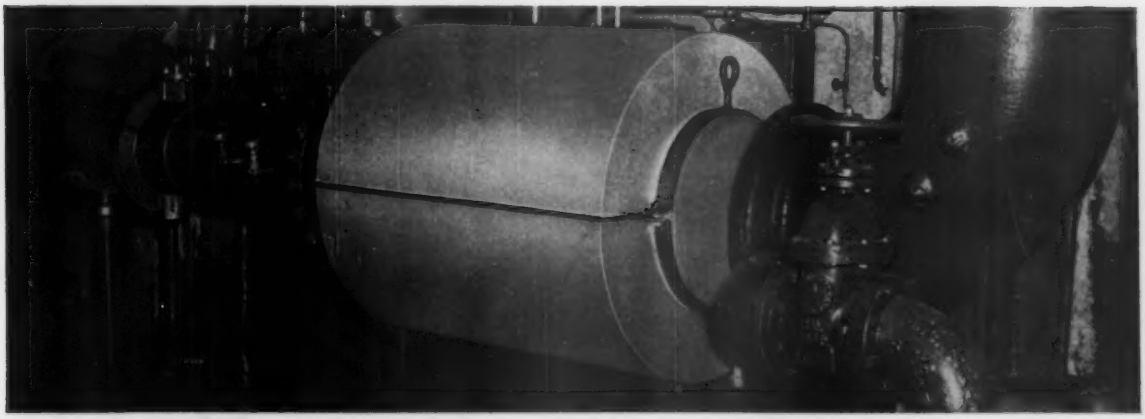
Benton Harbor, Michigan	— raw sewage
Hayward, Calif.	— water
Pittsburgh, Pa. (Allegheny County Sanitary Authority)	— raw sewage
Covington, Ohio	— return activated sludge
Warren Township, Michigan	— raw sewage and sludge
Bloomfield Township, Michigan	— water
Seattle, Washington (Lake City Sewage Plant)	— sludge
Milwaukee, Wisconsin	— sludge
Piqua, Ohio	— sludge
Arkansas City, Kansas	— sewage
Sidney, Ohio	— return activated sludge
Frazer, Michigan	— raw sewage

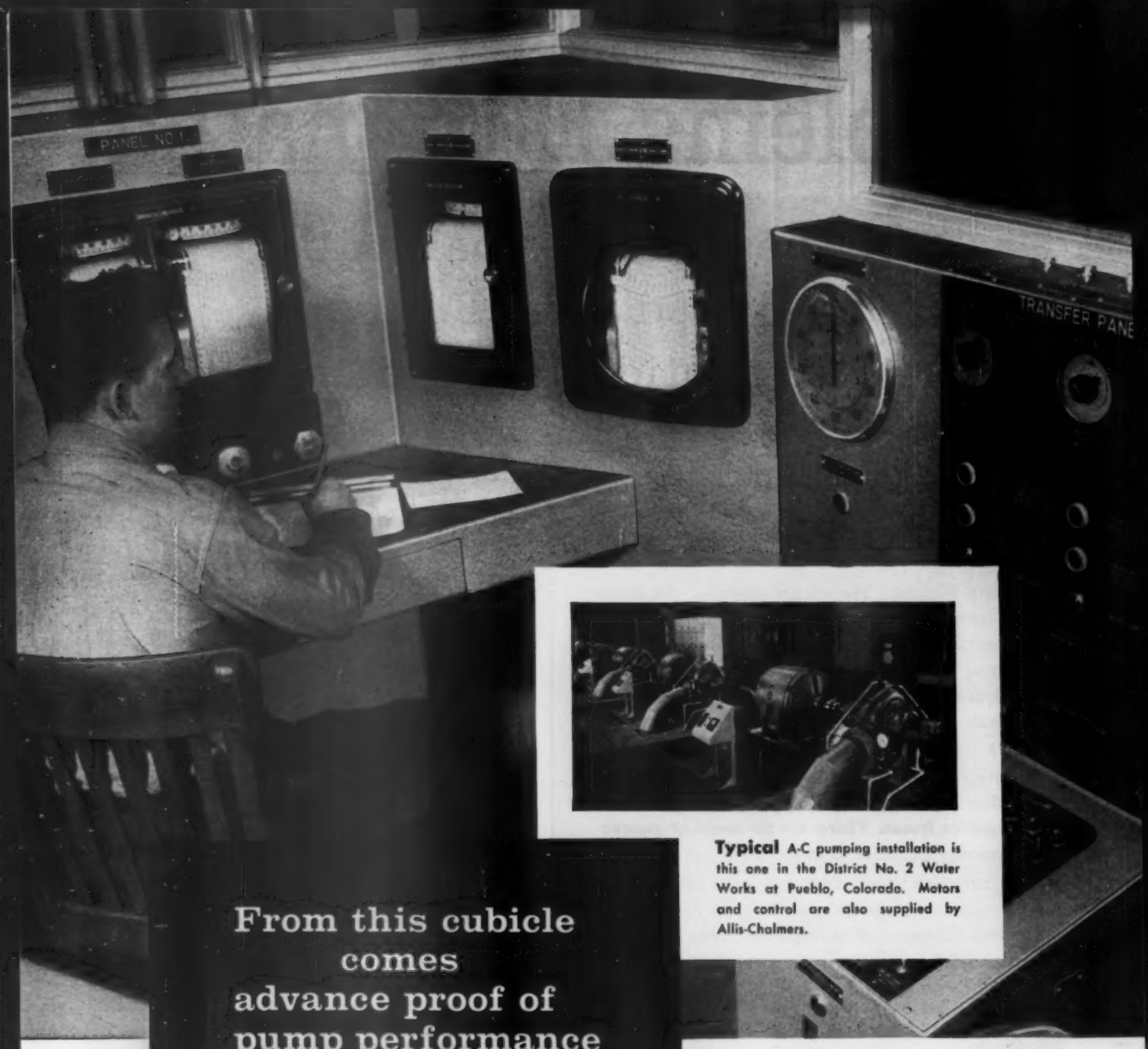
Meter sizes on these installations range from 3 inches to 6 feet.

CHICAGO, ILLINOIS

This 20" Foxboro Magnetic Flow Meter was installed in the South District Filtration Plant in April, 1956. Because it has no line restrictions, plant officials knew the meter would add no more pressure drop than an equivalent length of pipe. Note how it was installed directly downstream from an elbow.

FOXBORO
REG. U.S. PAT. OFF.





Typical A-C pumping installation is this one in the District No. 2 Water Works at Pueblo, Colorado. Motors and control are also supplied by Allis-Chalmers.

From this cubicle comes advance proof of pump performance

This master control room of Allis-Chalmers pump test floor is far removed from public works installations. Yet, engineers working here know exactly what your needs are — and which Allis-Chalmers pump will best do the job.

Suction heads, discharge heads, gpm capacity, required horsepower plus other essentials for satisfactory pumping performance are all proven in advance.

Performance testing like this is only one reason why A-C is recognized as a full-line leader in meeting the pump needs of municipals. "Teamed" motors and control; customized standardization of parts and materials; engineering assistance and nationwide service are others.

Whatever your requirements in centrifugal pumps — from the smallest to 250,000-gpm giants — contact your A-C representative or distributor. Or write to Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

Plan to stay ahead... MODERNIZE!

ALLIS-CHALMERS

A-5981-PW

BADGER'S COMPOUND WATER METER ASSURES FULL REVENUE FOR ALL WATER DELIVERED

Wherever water flow rates fluctuate considerably during the day — in schools, factories, hotels, theaters, apartment houses, dairies, laundries — Badger's compound meter assures economical, efficient service.

This compound meter combines Badger's disc and turbine meters to provide accurate registration at all rates of flow. You get the full revenue to which your water department is entitled for water actually delivered.

It is the industry's only compound meter where only one side operates at a time. A patented balanced compounding valve directs small streams through the disc meter, large streams through the turbine side... for accurate measurement of all rates of flow, less wear and longer service life.

Write for complete details now.

Badger Water Meters

BADGER METER MFG. CO. • 4545 W. Brown Deer Rd. • Milwaukee 16, Wisconsin • *Offices in principal cities*

Here's how they install a concrete distribution line in Marrero, Louisiana

In this photo, the backhoe operator has just finished digging the trench and is now lowering the 16-foot length of prestressed concrete steel-cylinder pipe into position. Workmen are guiding it under an existing service line running across the trench.

Here the operator is carrying the pipe forward to make the joint with the section already installed. The steel-and-rubber-gasket goes together quickly and makes a bottle-tight connection. This method was used on 23,000 feet of 16-inch and 4,000 feet of 20-inch line.

This fellow's job is to grout the joint after the pipe is installed.

High-lift was used to backfill and to handle the pipe on this job.

Although this type of pipe goes in quickly, its biggest advantages are long life (concrete gets harder and tougher the longer it stays underground), high beam strength (steel cylinder resists earth movement and traffic loads) and high capacity (concrete core is ideal for flow of water). Fromherz Engineers, New Orleans designed the project and Harbert Construction Corporation, Birmingham handled construction for the Jefferson Parish Waterworks District No. 3. Pipe was manufactured by Price Brothers Company, with headquarters plants in Hattiesburg, Miss., and Dayton, Ohio.

Price Brothers

Help control Water Department costs—

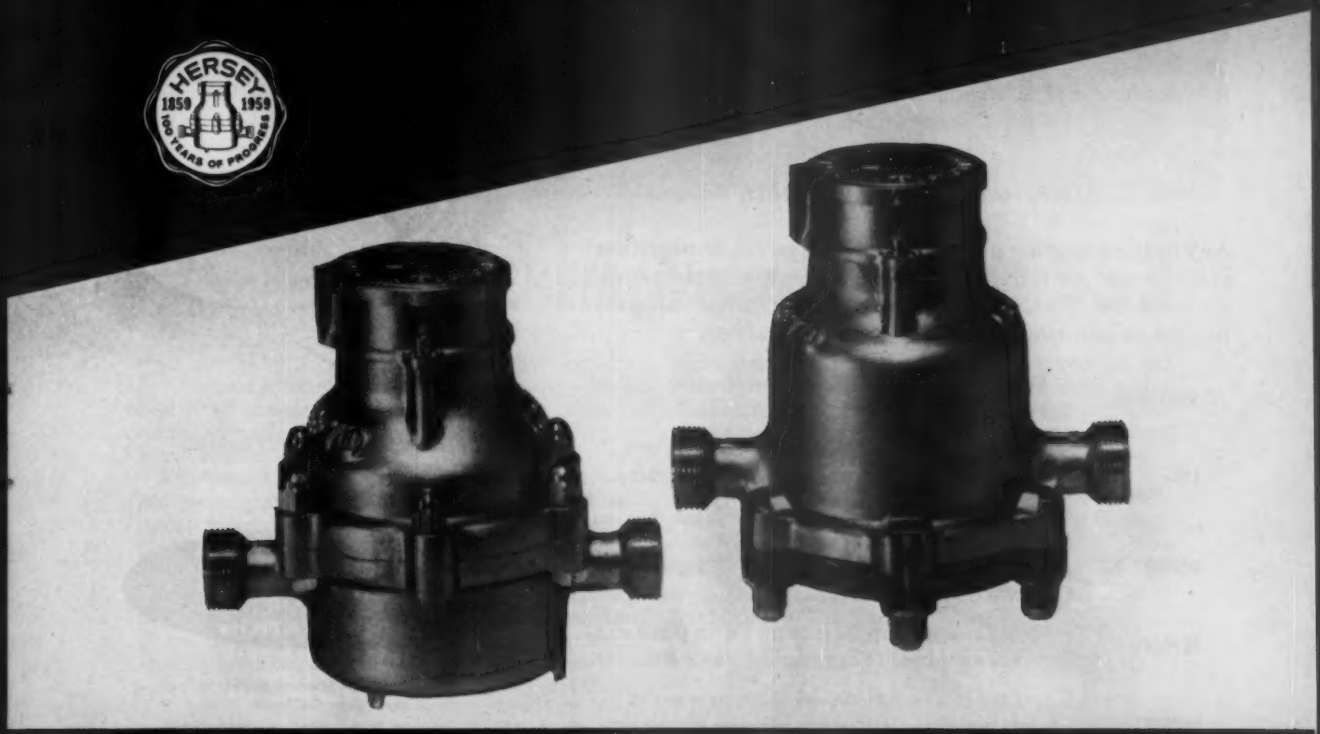
1. By accurate registration of all water sold.
2. Meter all services—homes, factories, public buildings.
3. Use water meters with proven low maintenance costs.

HERSEY WATER METERS

are the world's best!

Remember — you can't buy a better water meter than **HERSEY.**

Contact our nearest branch office or write the Home Office for full details.

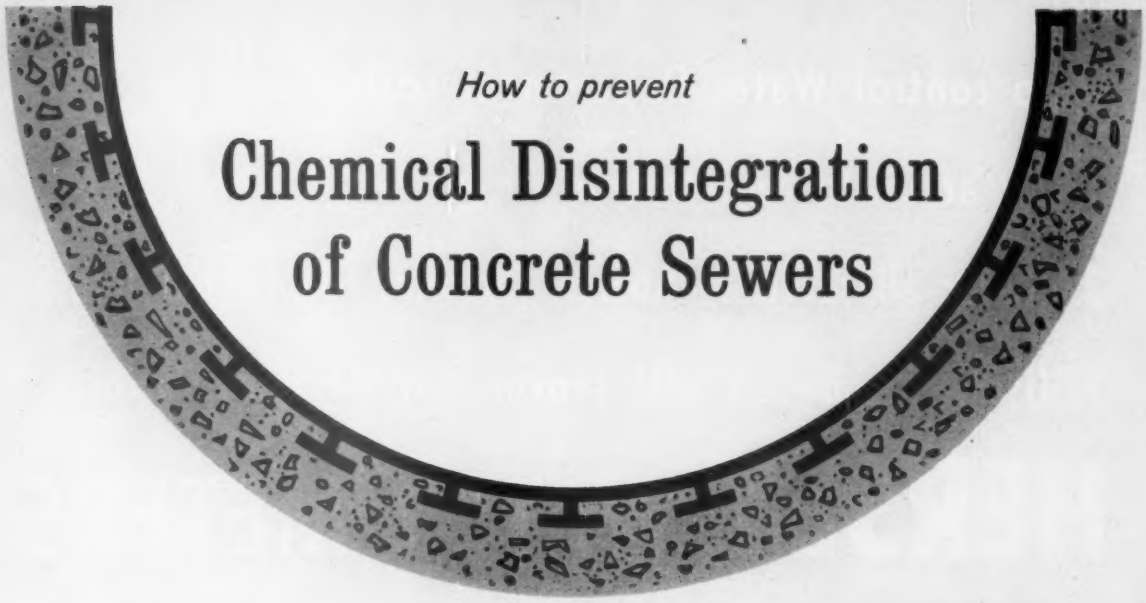


HERSEY MANUFACTURING COMPANY

(Established 1859)

DEDHAM, MASS.

BRANCH OFFICES: NEW YORK — PORTLAND, ORE. — PHILADELPHIA — ATLANTA — DALLAS — CHICAGO
SAN FRANCISCO — LOS ANGELES

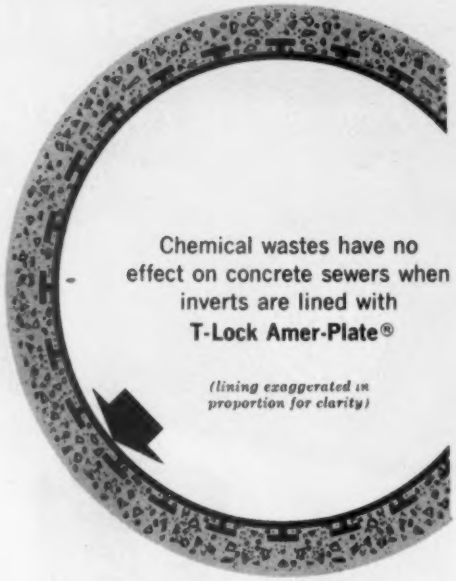


How to prevent

Chemical Disintegration of Concrete Sewers

T-Lock Amer-Plate is a high polymer PVC sheet, easily cast into pipes, tunnels and structures to form a partial or complete 360° protective lining. Used in inverts, it permanently protects concrete from corrosive chemical effluents. In arch areas, it positively stops oxidized H_2S corrosion. T-Lock is also highly abrasion resistant; impartial tests show that it abrades at only 1/70th the rate of concrete.

The fact that T-Lock ends erosion and corrosion problems in industrial and municipal sewer systems is attested to by more than five million square feet now in use.


Chemical wastes have no effect on concrete sewers when inverts are lined with
T-Lock Amer-Plate®
(lining exaggerated in proportion for clarity)

WRITE FOR THIS FREE DATA

Any of the following printed pieces may be obtained without obligation by writing to Amercoat Corporation at the address shown below. Perhaps the information contained will prove helpful to you when designing your next sewer.

BROCHURE: T-Lock Amer-Plate, locked-in protective lining for concrete pipe, tunnels and structures.

LIST: Sewers in which T-Lock Amer-Plate has been installed, including names of purchasing bodies, locations, dimensions and dates.

REPRINT R-6: Wichita's new sewer is plastic lined to protect concrete from sulfide gas (Kansas Construction Magazine).

REPRINT R-7: How T-Lock was applied to a cast-in-place concrete sewer tunnel (Engineering News-Record).

REPRINT R-10: How City of Los Angeles protects new sewer against corrosion (Water & Sewage Works and Public Works).

REPRINT R-15: Try these tricks for faster lining of sewer tunnels (Construction Methods & Equipment).

Applicators strategically located throughout U. S. and Canada

Amercoat® CORPORATION

Dept. WH • 4809 Firestone Boulevard
South Gate, California

• 921 Pitner Avenue • Evanston, Illinois
• 360 Carnegie Avenue • Kenilworth, New Jersey
• 2404 Dennis Street • Jacksonville, Florida
• 6530 Supply Row • Houston, Texas

110 A

... specify PITT CHEM *Insul-Mastic* 553

Do you have a corrosion problem that requires the protection of a heavy duty coating *plus* a degree of thermal insulation? You can solve it efficiently and economically with a *single* coating—*Insul-Mastic 553.*

This tough, durable mastic contains a high percentage of granulated cork. Applied to a 3/8" thickness, it will reduce heat loss through steel plates 40 to 65% . . . and provide excellent condensation control.

Because it is formulated with mica and a high percentage of Gilsonite, Insul-Mastic 553 is virtually unaffected by acids, alkalis, moisture and weather. It can be spray-applied in one continuous, uniform coating to metal, masonry or ceramic surfaces.

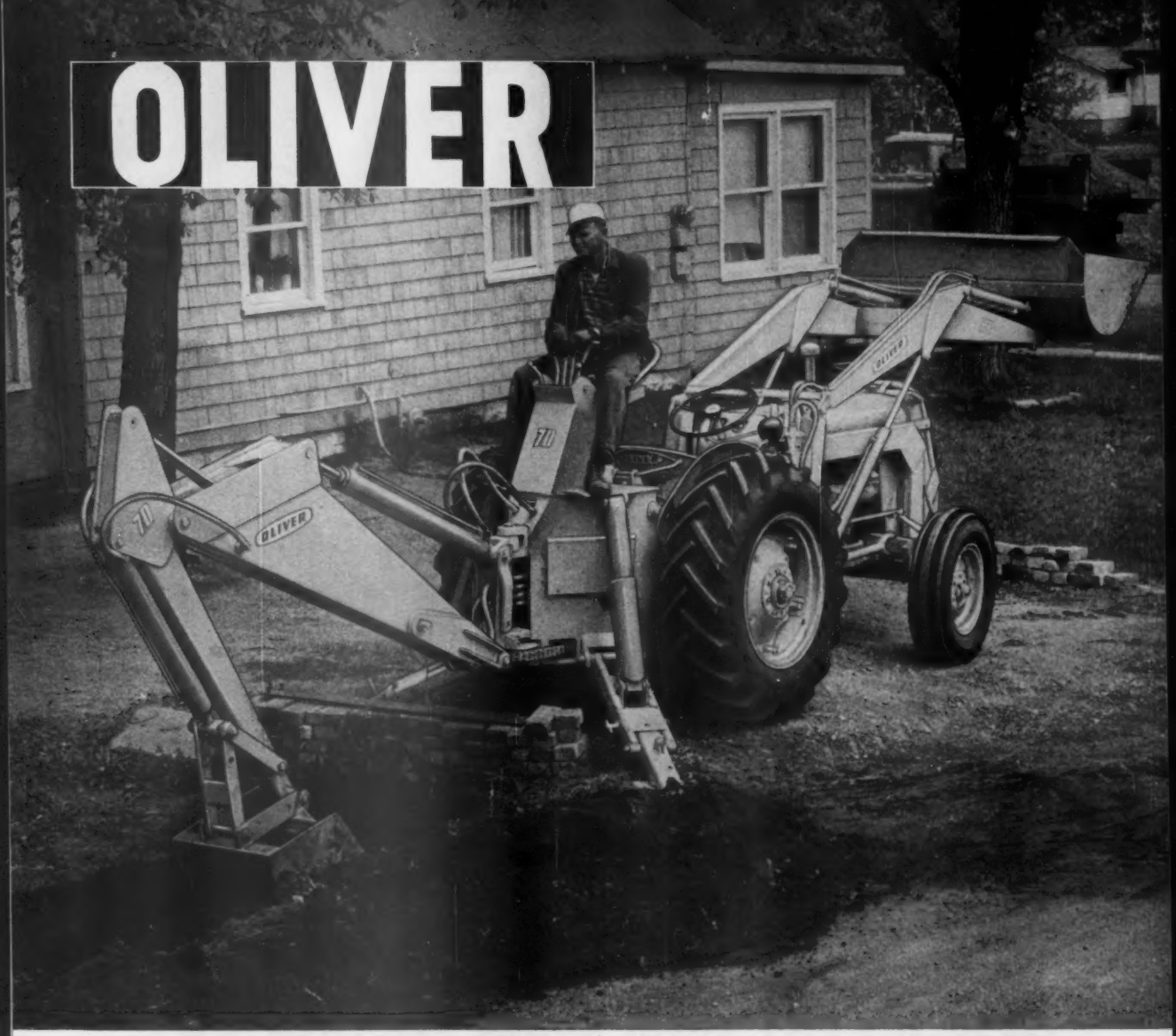
Refrigeration tanks, metal roofs, piping and metal sidings are just a few of the places where you can stop corrosion, reduce heat losses and prevent condensation with Insul-Mastic 553. *Call your Pitt Chem Distributor for full information and recommendations, today!*

PITT CHEM Industrial Coatings are available through leading Industrial Distributors. See the "Yellow Pages."

★ PITT CHEM "Insul-Mastic"® Gilsonite-Asphalt Coatings
★ PITT CHEM "Tarset"® Coal Tar-Epoxy Resin Coatings
★ PITT CHEM "Tarmastic"® Coal Tar Coatings

PROTECTIVE COATINGS • COAL CHEMICALS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON • FERROMANGANESE

OLIVER



TEST ITS WORK CAPACITY...COMPARE ITS COST...OLIVER 550

NEW OLIVER 550—today's newest utility tractor—with engine and built-in hydraulic system matched to perfection. It's fast, agile, full-powered. Its compact size lets it get in and out of tight spots quickly. Gas or diesel; independent PTO; six forward speeds, two reverse. Offers all big-tractor features at low price.

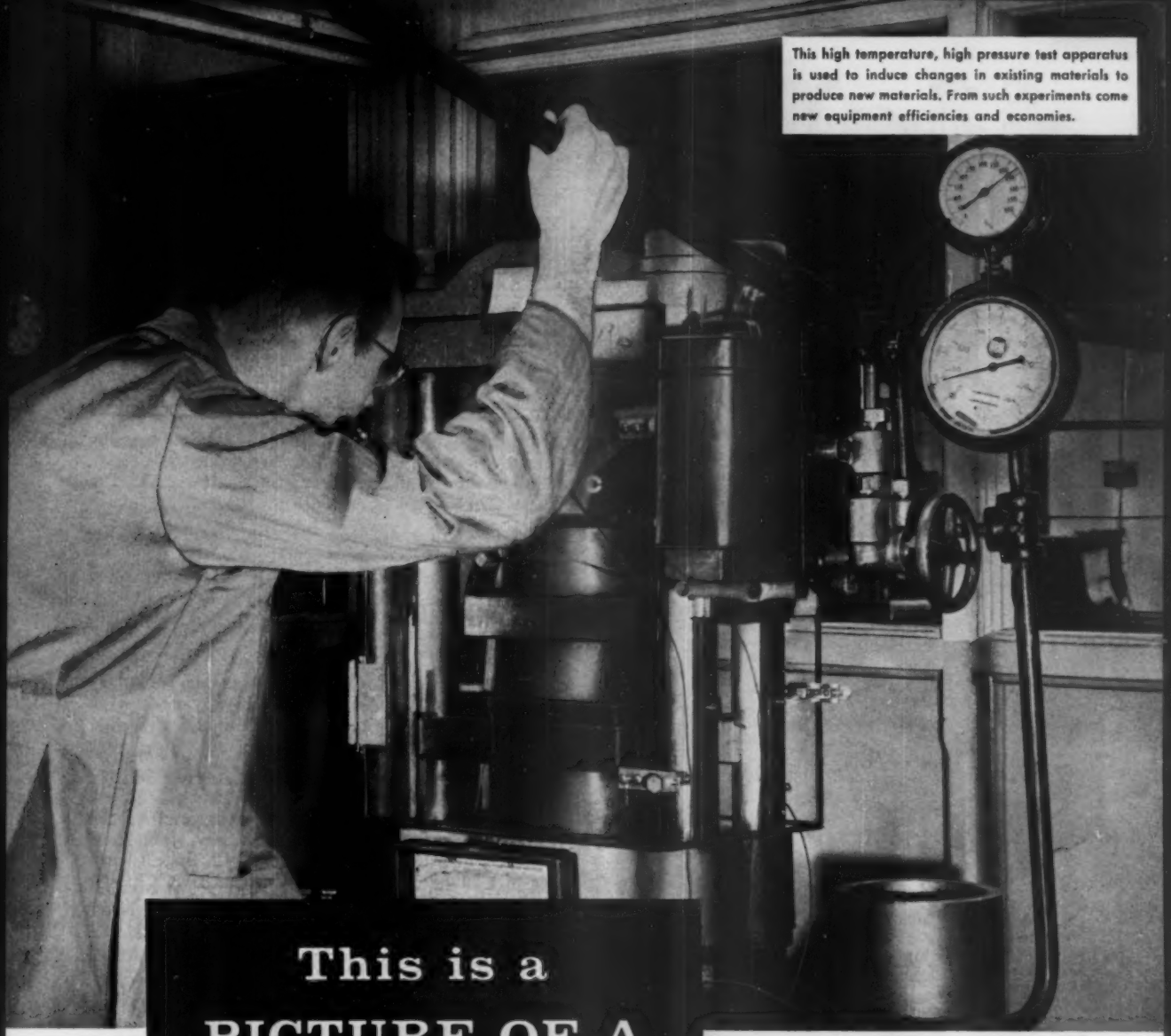
This new work-saving machine is *just right* for literally hundreds of jobs for municipalities, utilities, water and sewer departments. And you can't beat the combination of the Oliver 550 wheel tractor with the new backhoe and loader.

IT'S POWERFUL—with the highest ratio of h.p. to weight of any backhoe on the market. It delivers a 9000-lb. breakaway action, digs to 12′, loads to 8′8″.

IT'S FAST—with completely hydraulic operation, 188° arc of swing, fast work cycles, greatest production at lowest cost. Operator can quickly change from backhoe to loader by merely changing seats.

TRY IT! See for yourself how much better and faster this rig works on your jobs...how much less it costs. For free tryout, without obligation, call your Oliver distributor.

THE OLIVER CORPORATION
Industrial Division, 19300 Euclid Ave., Cleveland 17, Ohio
a complete line of industrial wheel and crawler tractors and matched allied equipment



This high temperature, high pressure test apparatus is used to induce changes in existing materials to produce new materials. From such experiments come new equipment efficiencies and economies.

This is a PICTURE OF A NEW PRODUCT

Products for Industry: Electrical Generation, Distribution and Utilization Equipment; Pumps; Compressors; Mechanical Power Transmission Equipment; Processing Machinery; Motors and Control; Water Conditioning Systems, plus Materials Handling Equipment.

No, it won't be available tomorrow—or even next year. But Allis-Chalmers is working on it *now* to meet the needs of public works in the future.

Continuous Research — at Allis-Chalmers — of materials, processes and equipment paces product development and technological advancement. *Creating a continuous flow of new equipment, improving existing products, helping public works and industry achieve new efficiencies and economies* — these are the assignments of Allis-Chalmers research.

Thus research contributes to establishing a pronounced preference for Allis-Chalmers public works equipment. But it's only part of the story. Single-source availability of "teamed" equipment, invaluable engineering help and outstanding service facilities are other important factors.

Talk to your A-C representative soon about your requirements. Or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Plan to stay ahead... MODERNIZE!

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

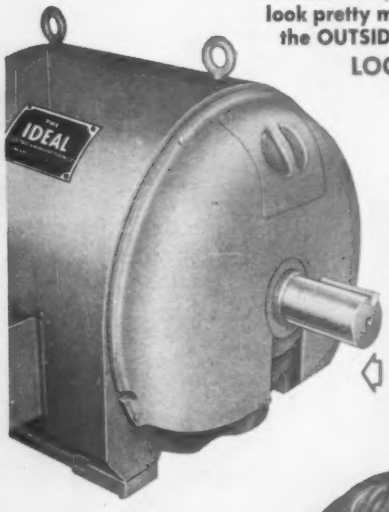
A-1004-PW

Quality

WHERE

QUALITY COUNTS!

GENERALLY, all motors look pretty much alike on the OUTSIDE, you say? LOOK AGAIN!



Check the one-piece steel plate cover running the full length of the frame and extending well below the centerline on each side. That means strength and protection for internal parts.

Now, notice the cast-aluminum end shrouds with recessed access plates. Protection again—plus a big assist in maintenance and servicing. Lift the plate for oiling and inspection. Lift off the shroud for repair and overhaul.

There is a difference, isn't there? And the INSIDE story is even better. Why not write for it today? Ask for Bulletin 210 (Squirrel Cage Induction Motors), Bulletin 220 (Wound Rotor) or Bulletin 501 (High-Seed Synchronous Motors).

IDEAL ELECTRIC

Your ONE source for every power requirement!

The IDEAL ELECTRIC & MANUFACTURING CO.

308 East First St. Mansfield, Ohio

SINCE 1903, AMERICA'S FINEST MOTORS, GENERATORS, MOTOR-GENERATOR SETS, SWITCHGEAR AND CONTROLS

Meetings

1959

Aug. 10-12—University Park, Pa. (*Pa. State University*)
PENNSYLVANIA WATER WORKS OPERATORS' ASSN. 32ND ANNUAL CONFERENCE, Secy., Harry A. DeWire, 29 Chestnut St., Lewistown, Pa.

Aug. 12-14—University Park, Pa. *(Pa. State University)*
PENNSYLVANIA SEWAGE & INDUSTRIAL WASTES ASSN., Secy., J. R. Harvey, 996 S. Main Street, Meadville, Pa.

Aug. 13—Vinal Haven, Maine
MAINE WATER UTILITIES ASSN., Secy., G. F. Laurin, 89 Western Ave., Augusta, Maine

Aug. 17-21—Cincinnati, Ohio (*Taft San. Engrg. Center*)
SHORT COURSE "RECENT DEVELOPMENTS IN WATER BACTERIOLOGY." Write: Chief, Training Program, 4676 Columbia Pkwy., Cincinnati 26, Ohio

Aug. 27—Springfield, Ill. (*Abraham Lincoln and St. Nicholas Hotels*)
3RD WATER SUPPLY CONFERENCE sponsored by the Illinois State Chamber of Commerce, Secy., J. G. Ronchetto, Water Resources Committee, Ill. State Chamber of Commerce, 20 North Wacker Drive, Chicago 6, Ill.

Sept. 2-4—Huron, So. Dak. *(Marvin-Hughitt Hotel)*
SOUTH DAKOTA WATER & SEWAGE WORKS CONF., Secy., Don C. Kalda, Pierre, So. Dak.

Sept. 8-10—Moran, Wyoming (*Jackson Lake Lodge*)
ROCKY MOUNTAIN SECTION, A.W.W.A., Secy., V. A. Vaseen, 833 - 23rd St., Denver 2, Colo.
(Jointly With)
ROCKY MOUNTAIN SEWAGE & INDUSTRIAL WASTES ASSN., Secy., Verne E. Plath, P. O. Box 149, Englewood, Colo.

Sept. 9-11—Milwaukee, Wis. *(Hotel Schroeder)*
WISCONSIN SECTION, A.W.W.A., Secy., Harry Breimeister, City Engrs. Office, City Hall, Milwaukee 2, Wis.

Sept. 9-11—Atlanta, Ga. (*Ga. Inst. of Tech.*)
GEORGIA WATER & SEWAGE ASSN., Secy., A. T. Storey, 1210 Hemphill Ave., N. W., Atlanta, Ga.

Sept. 9-11—Liverpool, Nova Scotia, Can. (*White Point Beach Lodge*)
MARITIME BRANCH, CANADIAN SECTION, A.W.W.A., Secy., J. D. Kline, Public Service Commission, P. O. Box 608, Halifax, N. S.

Sept. 13-18—Atlantic City, N. J.
136TH NATIONAL MEETING AMERICAN CHEMICAL SOCIETY, Secy., H. B. Gustafson, P. O. Box 5033, Tucson, Ariz.

Sept. 14-16—Lexington, Ky. *(Lafayette Hotel)*
KENTUCKY-TENNESSEE SECTION, A.W.W.A., Secy., J. Wiley Finney, Jr., Howard K. Bell, Cons. Engrs., 553 South Limestone St., Lexington, Ky.
(Jointly With)
KENTUCKY-TENNESSEE INDUSTRIAL WASTES & SEWAGE WORKS ASSN., Secy., S. Leary Jones, Cordell Hull Bldg., Nashville, Tenn.

Sept. 16-18—Minneapolis, Minn. *(Pick-Nicollet Hotel)*
NORTH CENTRAL SECTION, A.W.W.A., Secy., L. N. Thompson, Gen. Mgr., Water Dept., St. Paul 2, Minn.

Sept. 16-18—Upper Saranac Lake, N. Y. *(Saranac Inn)*
NEW YORK SECTION, A.W.W.A., Secy., Kimball Blanchard, 19 W. 50th Street, New York 20, N. Y.

Sept. 20-23—Lake Placid, N. Y. *(Lake Placid Club)*
NEW ENGLAND WATER WORKS ASSN., Secy., Joseph C. Knox, N.E.W.W.A., 73 Tremont St., Boston 8, Mass.

Sept. 23-25—Grand Forks, No. Dak. *(Dacotah Hotel)*
DAKOTA WATER & SEWAGE WORKS CONF., Secy., W. Van Heuvelen, c/o State Dept. of Health, Bismarck, N. Dak.

Sept. 23-25—Saginaw, Mich. *(Bancroft Hotel)*
MICHIGAN SECTION, A.W.W.A., Secy., T. L. Vander Velde, State Dept. of Health, DeWitt Road, Lansing 4, Mich.

Sept. 27-29—Kansas City, Mo. *(Hotel President)*
MISSOURI SECTION, A.W.W.A., Secy., Warren A. Kramer, Div. of Health, State Office Bldg., Jefferson City, Mo.

Sept. 27-30—St. Paul, Minn. *(St. Paul Hotel)*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Secy., F. J. Van Antwerpen, 25 W. 45th St., New York 36, N. Y.

Sept. 28-30—Toronto, Can. *(Royal York Hotel)*
CANADIAN INSTITUTE ON SEWAGE AND SANITATION, Secy., Dr. A. E. Berry, 72 Grenville St., Toronto, Ontario, Can.

Oct. 7-9—Baltimore, Md. *(Sheraton Belvedere Hotel)*
CHESAPEAKE SECTION, A.W.W.A., Secy., Carl J. Lauter, 6955 - 33rd St., N.W., Washington 15, D. C.

Oct. 8—Kingfield, Me.
MAINE WATER UTILITIES ASSN., Secy., G. F. Laurin, 89 Western Ave., Augusta, Maine

Oct. 8-9—Pocatello, Idaho
INTERMOUNTAIN SECTION, A.W.W.A., Secy., W. C. Hague, Chief Engr., Metropolitan Water Dist., 703 Tribune Bldg., Salt Lake City, Utah

Oct. 12-15—Dallas, Texas *(Statler Hilton Hotel)*
FEDERATION OF SEWAGE & INDUSTRIAL WASTES ASSN., Exec. Secy., Ralph E. Fuhrman, 4435 Wisconsin Ave., N.W., Washington 16, D. C.

Oct. 14-16—Des Moines, Ia. *(Hotel Fort Des Moines)*
IOWA SECTION, A.W.W.A., Secy., J. J. Hail, Supt., Water Dept., City Hall, Dubuque, Iowa

Oct. 18-21—New Orleans, La. *(Roosevelt Hotel)*
SOUTHWEST SECTION, A.W.W.A., Secy., Leslie A. Jackson, Municipal Water Works, Robinson Memorial Auditorium, Little Rock, Ark.
(Jointly With)
ALA.-MISS. SECTION, A.W.W.A., Secy., Ernest Bryan, McWane Cast Iron Pipe Co., Box 2601, Birmingham, Ala.

Ferri-Floc
FERRIC SULFATE

The Superior COAGULANT With The Plus FACTORS

- Excellent taste and odor control
- Increased filter runs
- Coagulation over wide pH ranges
- Rapid floc formation
- Turbidity removal
- Color removal
- Manganese and Silical removal
- Bacteria removal
- Ease of operation

Economy

Ferri-Floc gives smoother, more efficient and trouble free operation. Whatever your particular water treatment problem may be, you can depend on Ferri-Floc doing a superior job and doing it efficiently and economically—Ferri-Floc is a free flowing granular salt which can be fed with few modifications through any standard dry feed equipment. It is only mildly hygroscopic, thereby permitting easy handling as well as storage in closed hoppers over long periods of time.

FREE BOOKLET Let us send you without charge, a 38-page booklet that deals specifically with all phases of coagulation—just send us a postal card.

SULFUR-DIOXIDE SO_2

SULFUR DIOXIDE is used most effectively for dechlorination in water treatment and to remove objectionable odors remaining after purification.

COPPER SULFATE safely controls about 90% of micro-organisms normally encountered in water treatment plants efficiently and more economically than any other chemical.

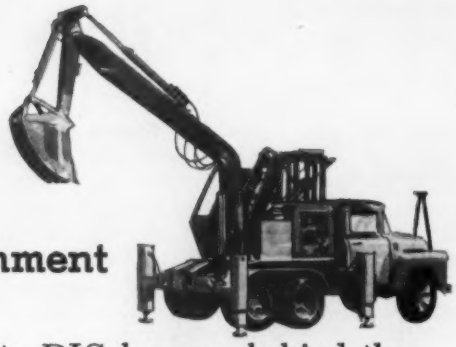
COPPER SULFATE

TENNESSEE CORPORATION
617-629 Grant Building, Atlanta, Ga.

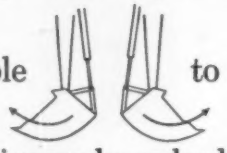
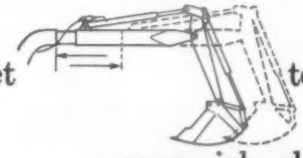
This is a

HYDROCRANE

...with a Hydrohoe attachment



and you can bet it's going to DIG because behind the teeth on that bucket is a combined total of 189,000 pounds of ram force! This machine has a combination of features that put it in a class by itself among half-yard hoes.

Here's why: The dippers for Hydrohoes, ranging from 24 to 60 inches wide, are reversible  to give you two-way digging action. Also, the dippers have hydraulic wrist action to bite in fast and hard. The boom on this hoe telescopes 4 feet  to give you efficient dumping reach for every job, eliminating unnecessary move-up time.

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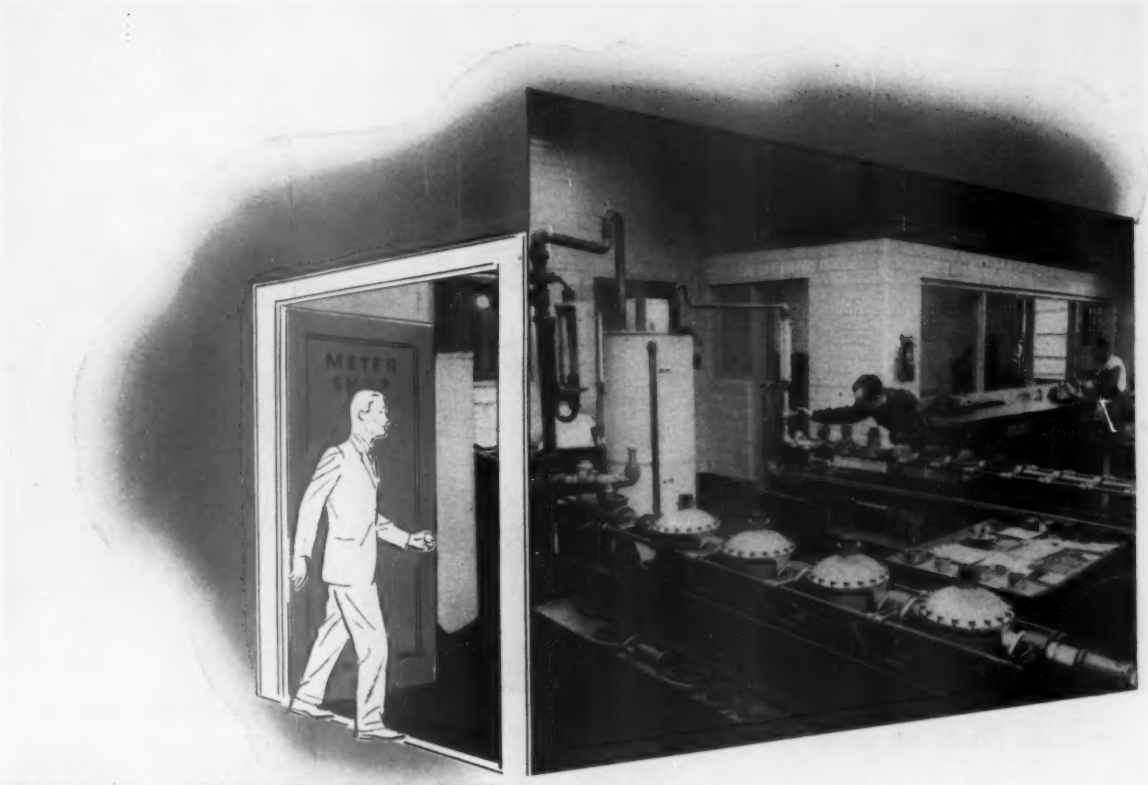

OPEN THIS DOOR

before you open the bids

You learn more about true meter costs when you open the meters for repairs than when you open the bids.

A water meter is a fine instrument, and any fine instrument loses accuracy as it wears. Because of this fact, written between the lines of any water meter price are two items of cost you can't read for many years.

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Vol. 106, No. 8 August, 1959 WATER & SEWAGE WORKS
A Scranton Gillette Publication

This is half the filter area of the—

New Treatment Plant
for Metropolitan London Water

by J. GRINDROD
New Milton, Honts
England

EDITOR'S NOTE: A new 90 mgd slow sand filtration plant has recently been added to the water system of Metropolitan London. Equipped with microstrainers, mechanical filter scraping and resanding equipment as well as gas turbine driven stand by generators, the plant is the largest and among the most modern in Europe.

■ IN ORDER to provide additional filtration capacity for their area of supply, a new waterworks has recently been taken into service by the Metropolitan Water Board at Ashford Common in the county of Middlesex, England. Among the many interesting features is the installation of gas turbines for standby pumping operations. This represents a new departure for the Board and is also probably the first occasion on which this type of machinery has been installed in a waterworks.

Forming a major part of the Board's post-war programme of development and constituting probably the largest complete filtration station and pumping plant ever constructed at one time in Europe, the new works are capable of filtering, treating and supplying 90 mgd of water.

Equipment

Covering about 125 acres, the site is conveniently situated for integration into the existing system of works operated by the Board in the Thames Valley. The Ashford Common works comprise two aeration basins, 24 micro-strainers, 32 slow sand filter beds, chemical treatment plant, two contact and balancing tanks, high and low lift pumping machinery, mains and ancillaries. They are so laid out that, when necessary, one half can be put out of commission, while a substantial proportion of the total output can be maintained from the other half.

Water will normally be received from the adjacent storage reservoir through a 100-inch tunnel. It may also be taken from either an existing 72 inch conduit or from the Staines group of reservoirs via the Staines Aqueduct. After purification, the water is pumped to districts in the north, west and south of London, as required.

On arrival at the purification plant, the water passes through two aeration basins, each of which is 90 ft. in diameter. The water is discharged upwards into the air in the shape of a hollow cone through a special valve which maintains a constant velocity at all rates of flow.

Operation

From the aeration basins, the water passes to a system of 24 micro-

FIG. 1 CONTROL ROOM Main Pumping Station

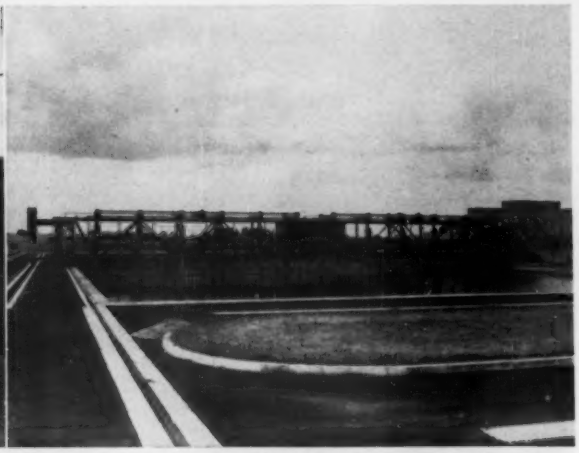


FIG. 2. HYDRAULIC SAND Washing machine for filters

strainers, each of which is 10 ft. in diameter and 10 ft. long. This installation is thought to be the largest of its kind so far constructed. Each strainer consists of a large cylindrical cage covered with a fine mesh, giving approximately 80,000 apertures per square inch. The water enters the cylinder through one end and passes through the mesh into the compartment outside, the cylinder rotating continuously about its axis. Cleaning of the micro-strainers is effected from the top of the cylinder, where small water jets are played on the mesh from the oustide. This washes the algae and other matter from the mesh into a trough inside the cylinder and the dirty water is carried away through the hollow shaft upon which the strainer is rotating.

Each of the 32 open slow sand beds, to which the water under treatment then passes, are about three-fourths acre with the similar dimensions of each allowing mechanical methods of sand handling and washing to be adopted. Each bed is composed of a 2 ft. thick layer of Redhill sand, supported by 3 in. of fine gravel resting upon a drainage system of "no fines" concrete, formed of channels 6 in. wide by 4 in. deep at 9½ in. on centers. The strained water enters the filter at one end through a baffled inlet chamber and the filtrate is collected into two 66-in. mains which convey it to the chemical treatment plant. The maximum rate of filtration is 4 gals. sq ft hour, equivalent to a downward flow of 8 in hour, or about 3.25 mgd. The full output of the station can be obtained with four beds out of use. Turbidity, taste and odor are removed, colour is considerably reduced, organic matter and natural ammonia are oxidized and bacteria largely disappear.

Filter cleaning

Two methods of mechanical filter-bed cleaning are provided. One involves the use of a hydraulic sand-washing machine carried on a bridge or gantry travelling on rail tracks between the beds. This cleans the sand without removing it from, or emptying, the bed. The other method employs a travelling sand-handling bridge which is used for skimming and resanding the beds. To facilitate mechanical cleaning, the sand surface in the filters is completely free from obstruction such as bell mouths and air vents. Inlets and outlets do not project into the bed, valve houses are located away from the edges of the filters and sampling facilities are provided in the valve houses.

From the filters the water passes to the chlorination points and thence into the contact and balancing tanks. Super-chlorination up to a maximum dose of 2.5 mg/L is used, the chlorine being injected before the water enters the contact tank. A residual chlorine recorder measures the free chlorine remaining as the water enters the contact tank after less than one minute contact and this can be used as a measure of the total chlorine demand. The chlorine dose is automatically controlled and can be set to maintain the residual at any predetermined figure, notwithstanding changes both in the quality of water being supplied and the rate of flow. Equipment for the injection of sulphur dioxide or ammonia has also been provided in a separate part of each chlorination house should this be necessary.

Of reinforced concrete, each of the contact tanks measures 360 x 216 x 14 ft. deep and has a capacity of 5.8 mil. gal., 2 mil. gals., being for balancing to equalise the load on the filters. Each tank is divided into two equal portions by a central division wall to the full height. The two halves can be used in series to give the full contact period of two hours or they can be used independently to allow either compartment to be isolated. The inlet pipes to the tanks terminate in fixed screens with stainless steel mesh of 40 wires to the inch to arrest any aquatic fauna or other unwanted matter which may develop in the filtered water system. As the tanks are constructed above ground level, the water has to be pumped into them and two small pumping stations serve this purpose.

Situated at the north end of the site, the main pumping station houses low-lift machinery for pumping unfiltered water from the reservoirs to the works and high-lift machinery for

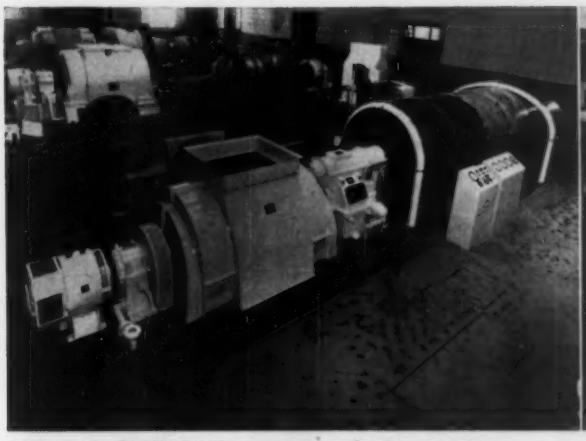


FIG. 3 GAS TURBINE generators during erection

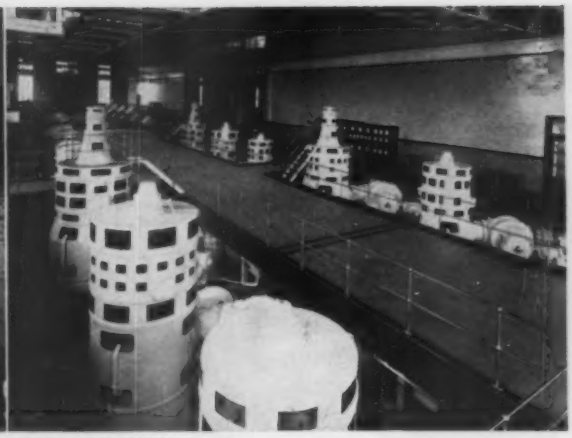


FIG. 4 HIGH LIFT filter water pumps

delivering purified water to the distribution system against heads of up to 320 ft. The building is divided into two main sections, one containing the low-lift stored water pumps and high-lift filtered water pumps, and the other the power generating plant. All the pumping machinery is electrically driven, current being supplied from the grid in normal circumstances. Generators driven by oil engines and gas turbines provide a standby and can be used for peak load relief.

Electrical equipment

Mains current for normal working is received at 22,000 volts, three-phase, through three 6 MVA transformers, distribution being at 3300 volts for the main pump motors and 415 volts for the auxiliary services.

As it is essential that no breakdown should occur in Greater London's water supply, 100% standby is provided for all plant except that for unfiltered water, which has been covered for standby purposes to the extent of 50%. The use of gas turbo-generator sets for standby power was decided upon since these combine high power outputs with small size and quick starting characteristics and since thermal efficiency is not the first consideration. The three machines installed are capable of taking over the station load should a complete breakdown of the grid power supply occur and their use will enable the Board to gain practical experience in this form of plant.

In addition, there are three General Motors 1,400 kva diesel-driven generator sets which are intended primarily for peak lopping duties in the winter months in order to reduce maximum demand charges, but they will also be used in summer periods for peak-load relief. These sets are, however, very noisy in operation and have, therefore, been enclosed in glazed sound-reducing booths provided with lights which enable the operator to observe the plant from the outside.

Gas turbines

Of the three gas turbo-alternator sets, one, supplied by Metropolitan Vickers, is a single-shaft machine. The two others, supplied by English Electric and Brush, are two-shaft types. The rating of the Metrovick set is 2,500 kw and it operates at 7,000 rpm with an overall thermal efficiency of 16.75%. It is a four-stage machine designed to operate at a temperature of 1,292°F. Gases from the combustion chambers reach the turbine through a six-branch manifold and the turbine drives a 15-stage axial compressor. The output of the alternator is 3,280 kva, 3,465 volts, 0.8 power factor, 3-phase, 50 cycle @ 1,500 r.p.m. Reduction gearing drops the high speed of the turbine to the correct generator speed.

A machine supplied by English Electric has a rating of 2,250 kw, 0.8 power factor, 3300 volts, 3-phase, 50 cycle @ 3,000 rpm. A two-shaft, open cycle, non-recuperative unit, it comprises a six-stage axial/single stage centrifugal compressor driven by a two-stage axial "charging" turbine, together with a mechanically separate two-stage axial "power" turbine.

One shaft of the third turbine set, by Brush, carries the two stages of high pressure turbine blading and a 14-stage axial flow compressor, driven 6,375 r.p.m. The other shaft carries the two stage low pressure turbine which drives, at 3,000 r.p.m., a directly-coupled generator with a capacity of 2,500 kw, 50 cycles.

All pumping and generating operations are controlled from a control room on the first floor of the pumping station. On the end walls of the room are electrical and hydraulic diagrams, while the control desks are located on the respective sides of the room overlooking the plant concerned.

Great care has been taken to construct a drainage system for the several types of effluent that would be adequate for all purposes and inherently safe. There are separate systems for filtered water; wash water, surface and raw water; and sewage. All filtered water retaining structures and conduits have been kept above the natural ground water level to guard against any possible ingress of ground water of unknown quality.

The new Ashford Common Waterworks were designed and the construction supervised entirely by the Board's engineering staff under the direction of the Chief Engineer, Mr. H. F. Cronin, C.B.E., M.C., B.Sc. (Eng), M.I.C.E., M.I. Mech. E., F.C.G.I. The civil engineering work was carried out on a cost plus fee with target basis, while the mechanical plant was obtained by tender. The total estimated cost of the project is £5,250,000.

Commonwealth Water Company solved one phase of the rapid expansion problem by designing a

Continuous Flow Meter Repair Shop

by THOMAS W. COLEMAN, Manager Commonwealth Water Co., Summit, N. J.

EDITOR'S NOTE: A careful analysis, utilizing time studies methods, of why Commonwealth's unit cost for meter repairs was rising and they were being hard pressed to handle the work load developed many useful facts. Among the most interesting was that the time of highly skilled and correspondingly highly paid mechanics was not being utilized effectively and rules on scrapping of worn parts were actually costing money. With this and other information developed by the study as a basis the meter shop was completely redesigned to provide for maximum utilization of manpower.

■ GROWING PAINS are the rule where a water system serves a rapidly expanding service area. The symptoms of meter shop growing pains were these:

The shop hard pressed in keeping up with the periodic tests as required by the State of New Jersey Department of Public Utilities, unit costs were rising, and the work load could not be increased economically by adding additional mechanics.

Time Studies Made

Using standard time study tech-

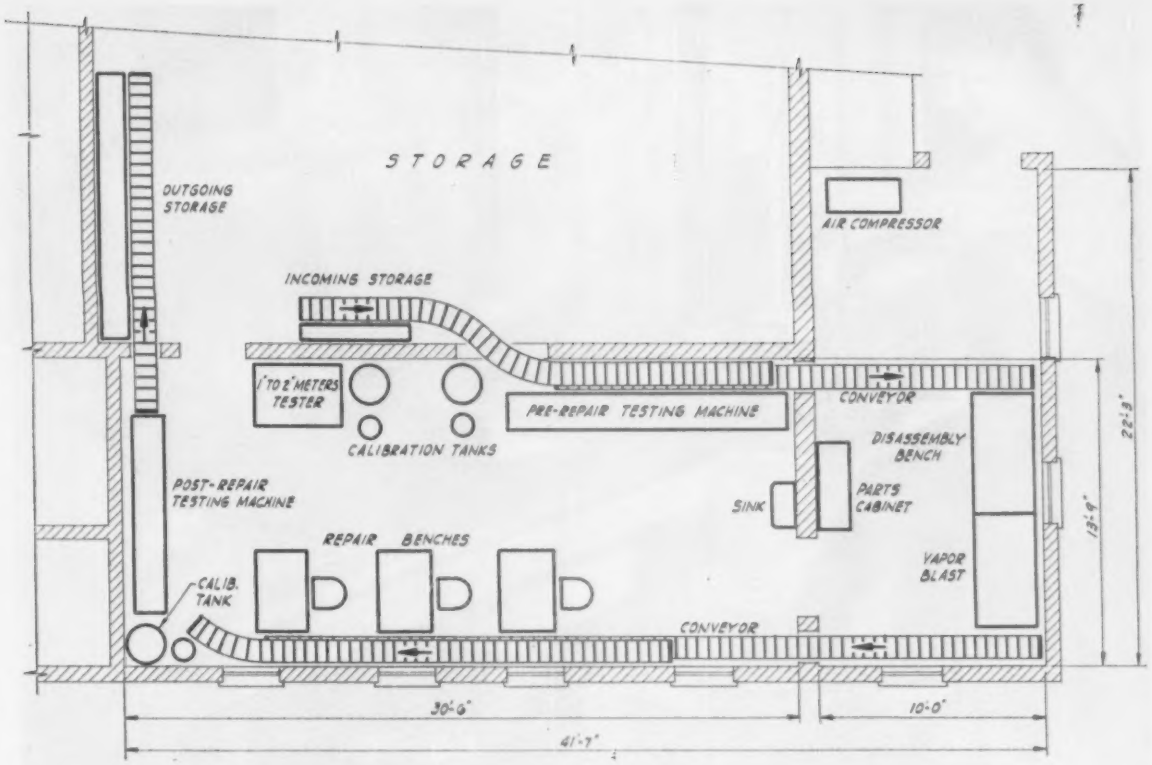


Fig. 1

niques the overall costs included in the total job were determined and then broken down to show costs in each individual operation. A list was prepared showing the individual operations used in bringing a meter into the shop, the necessary paper work involved, and the testing, cleaning and repair of the meter. A time study was made for each operation and individual costs ascertained.

The study pointed out several interesting facts. In order of descending importance, these facts were:

1. Our meter mechanics were spending too much time in work not at their highest capabilities. Meter cleaning and me-

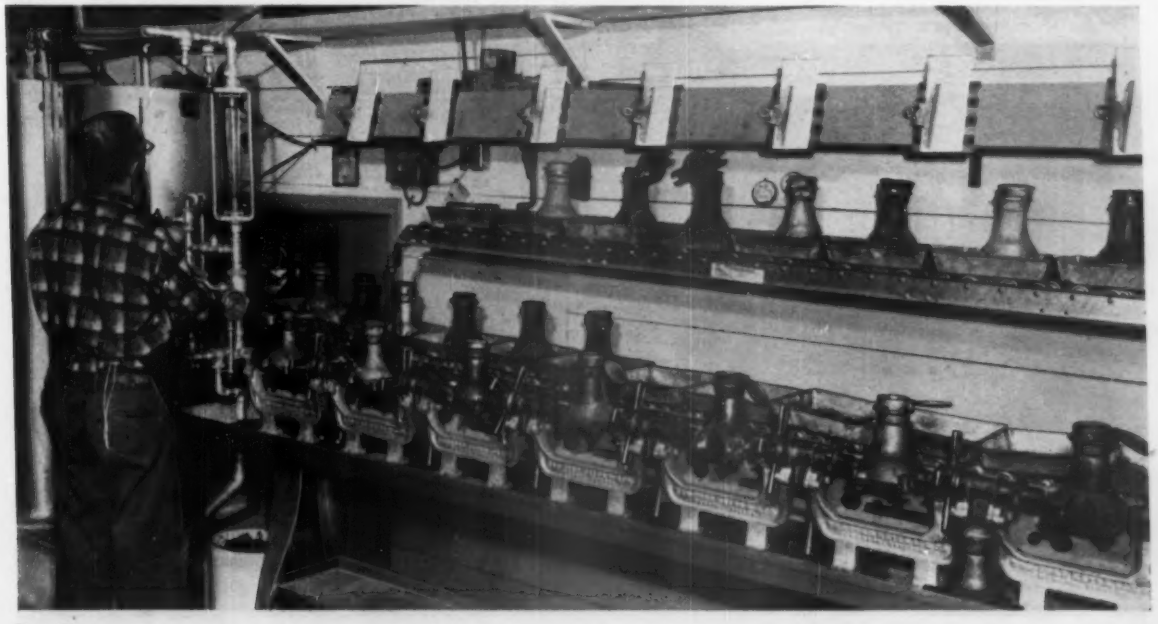


Fig. 2

Fig. 3

ter disassembly were using too great a percentage of their useful time.

2. We found that too much mechanics' time was being used in fitting and repairing old worn meter parts. The clearances in a meter disc or piston chamber are the key to a meter's sensi-

Fig. 4

Fig. 5

tivity and accuracy. A good mechanic using tricks of his trade can make a sensitive, accurate meter of old parts. Our time study showed that in many cases the use of new discs, control block and other parts was the economical method of repair. A new disc and disc chamber are known costs; they have little overhead to go with them. A mechanic's time, on the other hand, costs not only the hourly rate, but also the fringe benefits, the supervision cost, the payroll cost, and the variety of additive expenditures normal in modern industrial operation. As a result of this study, liberalized rules were set up for scrapping worn meter parts.

3. Too much time was being used by material handling. Delivery of meters to the testing rack, seeking out meter parts from a central stock, and handling of meters from cleaning operation to final assembly, all were using up too much productive time. Also different floor levels in the shop made the use of handling carts difficult and cumbersome. As a result, meters were being hand carried in several operations.
4. Our test procedure requires that a 5/8" meter be at least 90% accurate at the 1/4 gallon per minute rate and that the test quantity at this rate be one cubic foot. Thus this test alone took 30 minutes. Our testers were using a large part of this time watching the water level in the calibrated tanks.

Fig. 6

Meter Shop Redesigned

As a result of this time and motion study, the meter shop was completely redesigned. The new layout is shown on the drawing Fig 1. The underlying thinking in the new design was based on these principles:

1. Insofar as possible, all work was brought to the individual mechanic.
2. Specialization in work was demanded.
3. All dirt and odors were kept in an isolated room.
4. The various steps in meter repair and test were placed in logical sequence.
5. The quality and quantity of individual mechanics work should be measurable.

Commonwealth Water Co. supplies water principally to residential communities. As a result, well over 95% of our meter repair work is on 5/8" meters. For this reason, the shop was designed with this fact in mind. The comparatively few meters larger than 5/8" can also be tested on a special, large meter tester.

Repair Procedure

Fig 2 shows the first stage in the routine. This picture is taken in the storeroom and shows a number of meters being loaded in trays and starting on their way to the production line. The trays roll by gravity down a roller track into the testing room and come to a stop directly above the pre-repair tester. Prior to this time, a clerk had taken from the file the pertinent meter envelope if the meter had been repaired previously, and its enclosed report card. The previous date of repair was noted on the new report card and pertinent data recorded on it (make, size, reading, etc.).

Fig. 3 shows the pre-repair test bench and the roller rack feeding meters to it and the upper roller rack which removes the meters after preliminary test.

At the pre-repair test bench the meters are tested at three rates of flow in this sequence:

First, a ¼ GPM sensitivity test is run; at this rate of flow, one cubic foot is run into the tank.

Next, the intermediate flow test is run; at a 2 GPM rate. Again one cubic foot is run into the tank.

Finally, the large flow test is run at 15 GPM. In this case ten cubic feet are run into the large tank.

The sequence of these tests is important. When a meter has been in service for some time, a large flow test made initially may free up the disc. As a result, the tests made at the lower rates will give a false impression of the meter's accuracy at the lower rates.

After the initial tests are run, the meters are placed individually in the trays on the upper roller rack. This rack delivers the meters to the disassembly and cleaning room. However, not all meters are torn down. If a meter passes the test in all respects and has been in service fewer than five years, it goes directly to the stockroom to be placed in service. This exception in routine is based on experience. We have found that it has not been economic to tear down a meter which had fewer than five years service and passes the standard test.

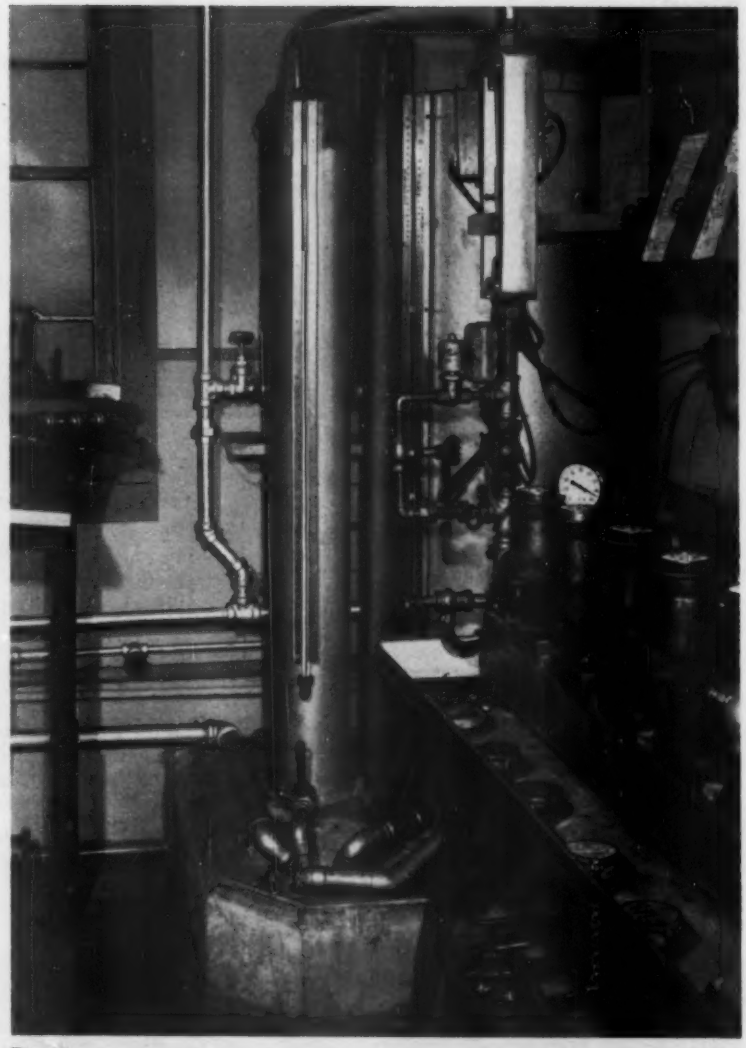


Fig. 7

Fig. 8

Fig. 4 and 5 show views of the disassembly and cleaning room, taken from opposite ends of the room. Here three meters at a time are placed in the disassembly vises. Using an impact wrench, the bolts are removed and the meter taken apart. Note the special funnel below the vises which deposists the dirt and trash into the removable trash pan below it. At this position, the meter is completely taken apart, loose dirt removed, and intermediate gear grease washed out with kerosine. All parts of each meter are kept in the individual tray.

Next, the parts are cleaned in the vapor blast machine, or liquid hone. Fig. 5 shows this operation. Again, each tray is handled individually and all parts to each meter are kept together in one tray.

After complete cleaning, the meter parts and tray roll down the roller path to the meter repair benches as shown on Fig. 6 and 7. These are the "clock makers" who reassemble the meter using new parts where necessary.

We are fortunate in having but two makes of water meters and for this reason the stocking of repair parts within arm's length of each man is possible. Sitting on a work stool, each mechanic has within reach all tools required, all spare parts required, a small sink with running hot and cold water, and compressed air.

Here, as mentioned earlier, a careful decision must be made where major new parts seem to be required. In case of doubt, the repair man sets the meter to one side until a decision can be had from his supervisor.

Particularly at these benches is good lighting essential. Each mechanic has good window light and ample artificial light to accomplish the close tolerance work necessary.

At the repair benches, the meters are completely rebuilt. If the old disc chamber is used, the change gears are retained as they were before disassembly. If a new chamber is used, standard trial gears are used. Of course, in either case, they can be changed at the post-repair testing machine.

As the meter has progressed through the shop, the report sheet has been in the tray. Now the repair parts used are entered on the report sheet and the rebuilt meter replaced in its tray. The tray with meter is placed on the roller path and progresses to the post-repair tester.

The post-repair tester is shown in Fig. 7. This unit is a high speed hydraulic clamp tester holding twelve meters in series. It is equipped with automatic electric control which stops the low and intermediate tests after one cubic foot has been drawn through the meters.

The high flow test is 15 GPM. At this rate, ten cubic feet are run into the tank and change gears replaced if necessary. If change gears are replaced, a rerun is made on that meter to check the proper selection of gears. Next, the intermediate test is run—a 2 GPM rate—the one cubic foot tank is used. Finally, the sensitivity rate of ¼ GPM is run, drawing one cubic foot of water. This test takes 30 minutes and is the real test of the quality of the repair work.

Note that in this post-repair test, the full-flow rate is run first. This is doe to indicate the correct change gears.

If the meter passes all tests, it is placed in its tray and rolls down the rack to the stock room near the place where it started on its trip. There it is sealed and capped and made ready to be returned to service. The report card is inserted in the envelope and filed away.

If the post-repair test is not within limits, the meter is returned to the mechanic who assembled it. The test will usually indicate why the meter failed and from that information the mechanic does the necessary adjustments before the meter is again tested.

The shop is now manned by three repair mechanics, one disassembly and cleaner operator, and the supervisor who does most of the test work.

Progress Report On Ohio River

Dr. Ralph E. Dwork, director of the Ohio State Department of Health, recently reported that more than 6 million persons were being served by municipal sewage treatment plants in Ohio by the end of 1958.

The total had grown from about 3.5 million at the end of 1952, and the residents of the state had spent more than $250 million to accomplish this gain.

In reporting on the progress made by industry, he stated that the number of industries with satisfactory waste control programs has nearly tripled since a water pollution control law became effective in 1952. Of the more than 600 industries which discharge wastes into waterways, 372 have "adequate" waste treatment facilities of waste control programs, 163 have some treatment facilities or control measures "not yet considered adequate," with 49 of them having improvement programs in the construction stage, and of the 71 factories with no treatment facilities, 31 have reached the construction stage.

Also, others among the 71 are engaged in active research programs on their waste problems or are merely awaiting completion of new municipal sewers into which they will be able to discharge wastes; among Ohio's 57 chemical industrial units, 41 have adequate treatment facilities and 14 some measure of control, with another to be able to discharge wastes into a municipal system shortly and the last changing its product which will make considerable difference in its waste problem and therefore call for a new approach to treatment.

Dr. Dwork said the state has a permit control program which permits "orderly, reasonable and steady progress" toward pollution abatement by each municipality or industry.

Hawaii Water Systems Unified

The two public water systems of the Island of Oahu, Hawaii, have been unified under the control and management of the Honolulu Board of Water Supply.

The Board of Water Supply, formed in 1929, was originally given authority over the properties, finances and operations of the water system of metropolitan Honolulu. The entire island of Oahu finally became a solid urban district, and as a result the unification of the water systems was authorized last December.

With the integration of the two systems, all the suburban employees have joined the Water Board and headquarters for the enlarged system is in the new Public Service Building which was erected by the Board of Water Supply last year.

Arthur R. Tyler, for many years executive head of the Suburban Water System, is now a top assistant to Edward J. Morgan, Manager and Chief Engineer for the Board of Water Supply, with the title of Superintendent, Suburban Water Division.

Part Thirteen of this series on centrifugal pumps takes up

Sleeve and Thrust Bearings

by IGOR J. KARASSIK, Consulting Eng. and Manager of Planning, Harrison Division, Worthington Corp., Harrison, N. J.

Sleeve Bearings

While antifriction bearings have replaced the plain cylindrical journal or sleeve bearing in the majority of centrifugal pump designs, there still remains a large field of application for this type of bearing. At the one extreme of this field the sleeve bearing is used for reasons of economy because it leads to a cheaper construction. For instance, certain small pumps used strictly for pumping clear liquids are provided with an internal sleeve bearing, as illustrated on Fig. 1. An internal sleeve bearing depends primarily on the liquid pumped for its lubrication and a water seal is sometime used in the center of the bearing, connected to the pump discharge whence liquid is introduced under pressure.

At the other extreme, sleeve bearings are used for large heavy duty pumps, when the shaft diameter reaches proportions such that antifriction bearings are not commonly available. Another typical application is that for high pressure multistage pumps, in which a combination of fairly large shaft diameters and high speeds from 3600 to 9000 rpm require the use of sleeve bearings. Still another example is the field of vertical submerged pumps, such as the vertical turbine pumps where the bearings are subject to water contact and antifriction bearings cannot possibly be used.

In addition, there are sometimes encountered personal preferences for sleeve bearings, preferences strong enough to warrant some pump purchasers to pay a premium when necessary for special design modifications to standard pumps which are then built with sleeve bearings instead of the usual ball bearing construction.

Most sleeve type bearings are oil lubricated and means must be provided so that the oil is properly fed into the bearing. As a result, vertical and horizontal shaft bearings vary considerably.

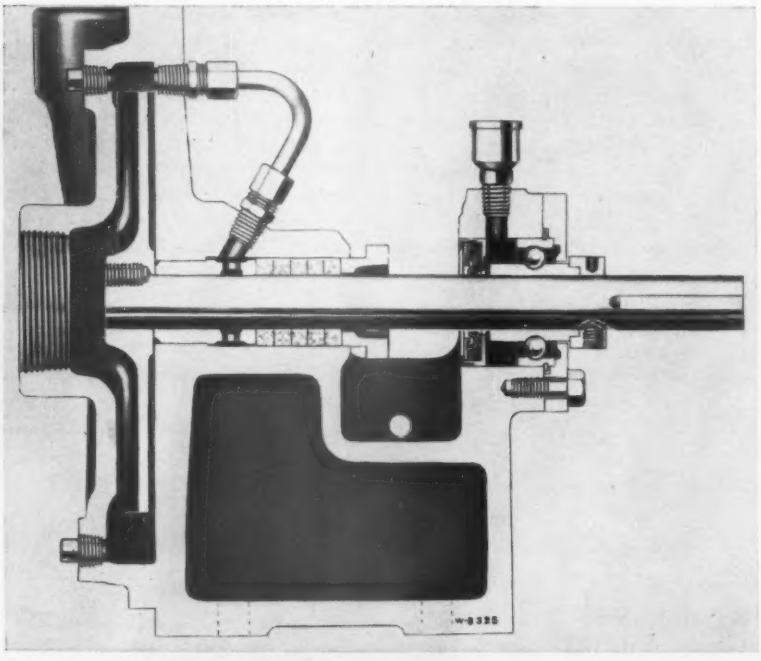


FIG. 1. INTERNAL Sleeve Bearing

For heavier duty applications, line sleeve bearings are generally of the self-aligning type. A self-aligning bearing adjusts itself automatically to small changes in the angular position of the shaft. This may be accomplished by providing the bearing shell with a spherical fit in the bearing housing, as illustrated in Fig 2. An equally satisfactory solution and one which results in a shorter bearing and shorter bearing span, consists in reducing the length of the bearing bushing engaged in the housing. (See Fig 3). This permits the bushing to rock slightly in its seat and compensate for changes in angular position of the shaft.

Various materials are used for the bearing bushings, but babbitted bearings are generally preferred for heavy duty service. The bearing bushing may consist of a babbit lining of ⅛ in. thickness or over, anchored in the cast iron bearing shell by means of dovetailed grooves. For better results, the shells are first tinned and the babbitt poured at the melting point of tin in order to insure a perfect bond.

There has lately been found a large field of application for the "precision" automotive type bearings which are now used for high speed pumps. This bearing is a split thin steel shell with a similarly thin deposit of babbitt. These bearings are available in the market in a wide range of sizes.

There is little application of sleeve bearings to horizontal pumps of the overhung impeller arrangement, and most applications involve pumps with bearings on both ends and arranged for drive through a flexible coupling. As a result, provision must be made for thrust. Several arrangements are used:

1) A sleeve radial bearing at one end and a babbitted type combined radial and thrust bearing at the other end.

2) Two sleeve bearings with a separate thrust bearing element either of the sleeve or antifriction type.
3) Sleeve radial bearings with babbitted shoulders or faces on the ends of the bushings, acting in conjunction with collars on the shaft.

This third type of combined thrust and radial bearing is, of course, the simplest design. It was quite popular when centrifugal pumps operated at much slower speeds than today and carried lower thrust loads. Generally, lubrication was supplied under a slight pressure between the shaft collar and the babbitted shoulder in the bearing shell.

When heavier thrust loads than usual are encountered it is now the practice to apply a Kingsbury or a Kingsbury type thrust bearing which is suitable for heavy loads and high speeds.

Kingsbury type thrust bearings

The Kingsbury bearing was first developed to meet the need for a suitable pivot bearing for vertical shaft turbines. Its application has gradually been extended to other types of rotary apparatus such as the centrifugal pump. Its principle is simple. An ordinary cylindrical or sleeve bearing has a running clearance between the bearing shell and the journal to provide for a lubricating oil film. By virtue of the relation of the curved surfaces, there takes place a "pumping" action, caused by the capillary attraction of the oil particles. This action draws a lubricating oil film into the space between the rotating journal surface and the inner bearing shell surface. (See Fig 3). If the oil is of correct viscosity, it will resist the breakdown of the oil film except at excessive loads. It is only necessary to provide a positive and ample supply of cool oil to the bearing. This is ordinarily accomplished by a simple gravity device, although in cases of the highest speeds resulting in maximum tendency to heat, some form of forced feed lubrication is used. In an ordinary thrust collar, subjected to high pressures and operating at high speeds, there is a tendency for the parallel surfaces to squeeze out this oil film. This results in metal to metal contact and makes this parallel plate type of bearing unsuitable for heavy loads.

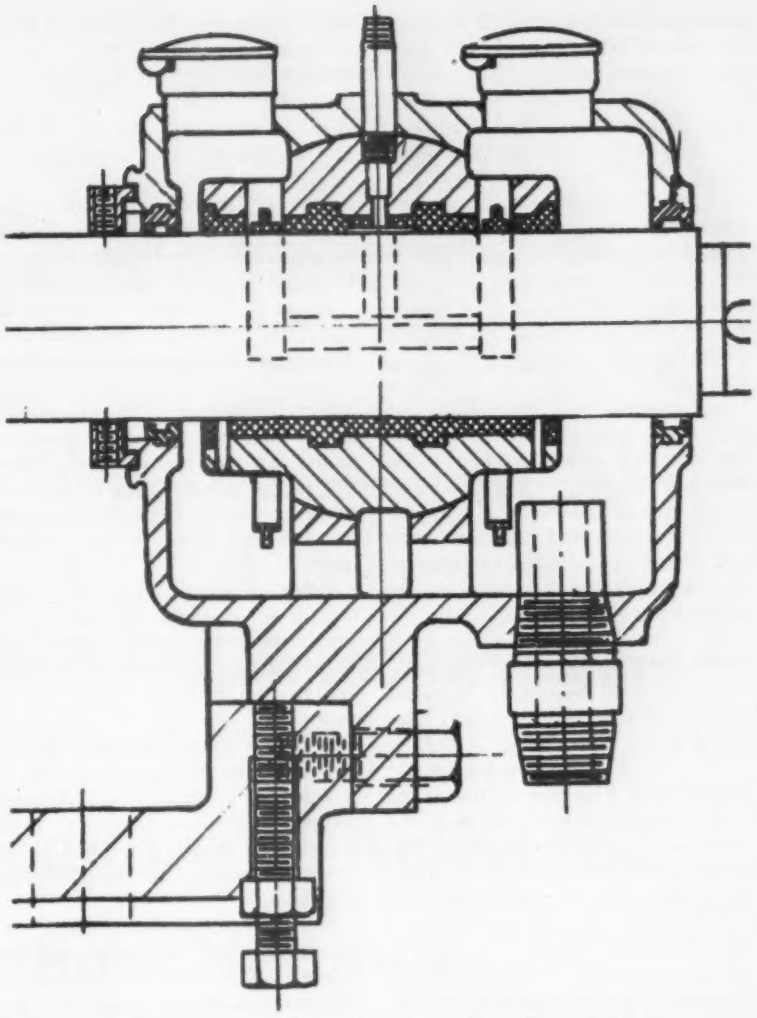


FIG. 2. SELF-ALIGNING sleeve bearing spherically seated.

The principle of the Kingsbury bearing can be described as follows: Suppose that a circular collar is cut into little segments and that each block is suitably supported on its underside. This permits it to rock slightly on the point indicated as the suspension point, suitable means having been provided to retain these blocks in location. When the shaft begins to rotate, there is a tendency, due to friction, for the film of oil to be dragged in under the slightly rounded edges of the blocks. As the speed increases, this tendency increases, the block adjusting itself slightly by tipping at a greater angle, riding up on the oil film as a sled runner rides up as when it meets the surface resistance of snow underneath it. The higher the speed, the greater this tendency to rock forward, permitting an increased "sledding" action, and an increasing tendency to adjust itself to the increasing oil film which is dragged under the block. Construction details of a typical Kingsbury bearing can be examined closely in the sectional assembly shown in Fig 4.

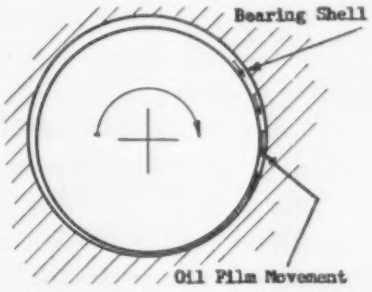


FIG. 3. ORDINARY CYLINDRICAL bearing with oil film formed by the pumping action.

The thrust mounting of Kingsbury

bearings used in horizontal pumps is arranged to take thrust in both directions. Sometimes both loads are approximately equal, while in other cases there may be a major thrust in one direction and an occasional minor thrust in the opposite direction. In any event, provision is made to limit the axial motion of the rotor and a Kingsbury bearing is provided with thrust shoes on each side. The number of shoes of each side may or may not be equal, depending on the type of application.

Kingsbury bearings are capable of taking care of unit thrust loads and high linear speeds so far in excess of the ordinary straight collar thrust that there can be no comparison between the two. Their cost is relatively high, however, and therefore their use, except where extreme thrust conditions are present, may not always be warranted.

Sleeve Bearing Lubrication

A ring oiled bearing is furnished with a soft steel oil ring which rides on the pump shaft through a slot cut in the middle of the top half of the bearing shell. This ring rotates as the shaft turns and picks up oil from the reservoir in the bearing housing. The oil is wiped off on the top of the pump shaft, flows between the bearing bore and the shaft and is discharged at the ends of the bearing. (See Fig. 2). Lubrication by means of oil rings is fully satisfactory only at relatively low operating speeds. A provision for automatically circulating the oil and—where necessary—for cooling it, is an essential feature of all higher speed sleeve bearings and especially of thrust bearings.

In some bearings, the soil circulation is effected by a rotary positive displacement gear pump directly connected to the outboard end of the pump shaft by means of a flexible coupling. (See Fig 4). The oil pump takes the oil from a reservoir located either in the bearing housing itself or separately on the pump baseplate and delivers it under pressure through the oil cooler. From the cooler, the lubricating oil flows in part to the outboard thrust bearing from which it flows into the reservoir located in the lower half of the bearing housing. It overflows by gravity from this reservoir into the main reservoir on the baseplate.

When using such a lubricating system, it is generally the practice to supply the inboard line bearing with oil under pressure through a branch line in the discharge from the oil cooler. The oil from the inboard is returned by gravity through large return lines into the main reservoir. It is essential to provide an adequate pressure drop from all bearings, so as to avoid the danger of oil leakage by overflow because of unsatisfactory evacuation.

There are obviously numerous alternate methods for supplying the bearing with forced feed lubrication. For example, some arrangements use a vertical oil pump driven from the main pump shaft by means of a worm gear. Other bearings employ the Kingsbury "adhesive" lubricated system. A pumping ring surrounds the thrust collar and dips into the oil bath. Oil clinging to the periphery of the collar is carried around inside the pumping ring and is forced into the thrust bearing cavity and into the journal bearing.

In some cases, the forced feed lubrication system of the pump supplies oil to the driver bearings as well, though this arrangement is generally limited to electric motor drivers only. When pumps are driven by steam turbines or through gears, it is customary to have the turbine or the gear supply oil to the pump bearings. In all such cases, it is essential that proper consideration be given to reconcile the requirements as to lubricating oil characteristics and operating temperature established by the manufacture of the individual pieces of equipment.

The use of oil rings for line sleeve bearings normally supplied with oil under pressure is optional and not always justified. Their function is basically that of supplying oil to the bearings at the start of the pump operation, before the forced lubrication system has had the time to provide adequate lubrication. However, sufficient oil is generally retained in the bearings to take care of the time lag before delivery of oil under pressure takes place.

When it is considered that the normal retention of oil in the bearing or the use of oil rings does not afford adequate protection, auxliary oil pumps are used. In some cases, a manually operated gear pump is provided and is used at scheduled intervals when the pump is standing idle. Operation of this auxiliary pump at weekly or bi-weekly intervals is generally sufficient to insure that oil does not drain out completely from the bearings or from the oil piping.

More elaborate lubricating systems incorporate a motor driven auxiliary oil pump which is started before the main pump is operated. The motor starter controls are interlocked in such a manner that the main motor cannot be started until the oil pressure in the system reaches a predetermined value. As soon as the oil pump driven from the main pump shaft develops sufficient pressure, the auxiliary oil pump motor is shut down by means of a pressure switch.

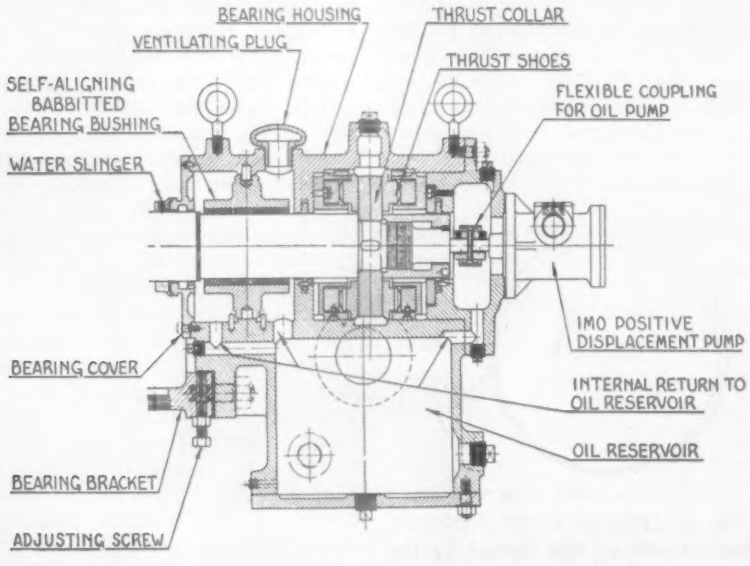
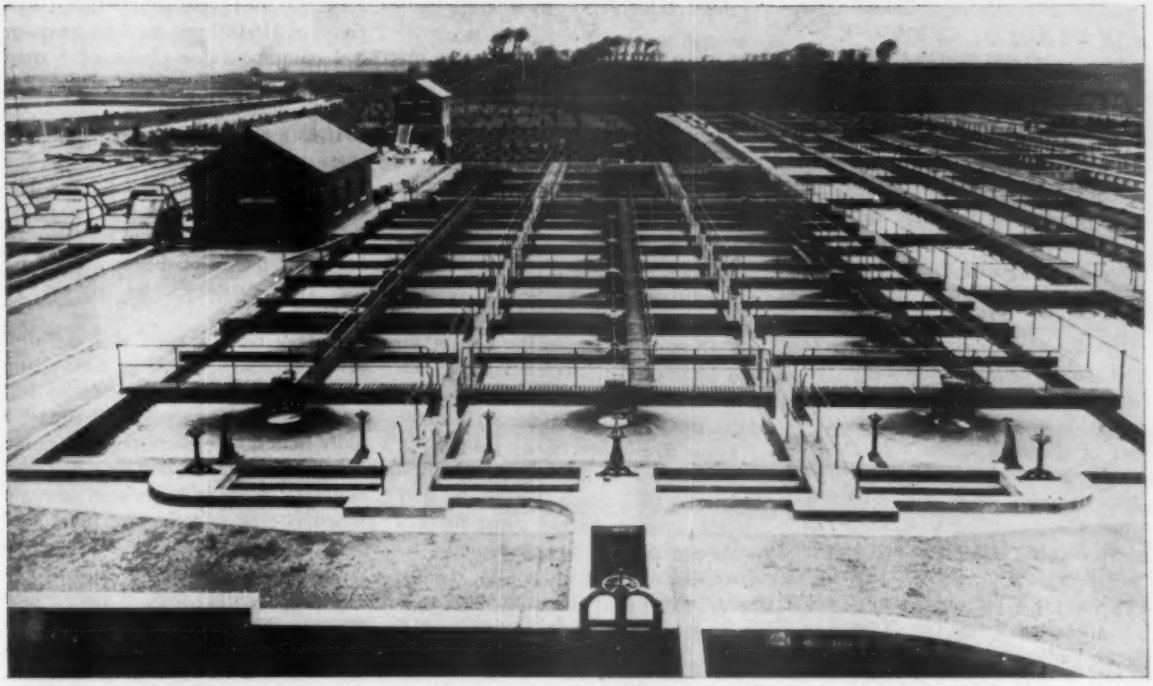


FIG. 4. SECTIONAL ASSEMBLY of Kingsbury type thrust bearing.



Application of surface aeration equipment at the Manchester, England plant shown above provided data for a study of . . .

Relative Economy of Activated Sludge Aeration Methods

by W. E. HOWLAND
Professor of Sanitary Engineering
Purdue University
Lafayette, Ind.

AUTHOR'S NOTE: Interest in mechanical or surface aeration for activated sludge has been renewed as a result of the publication over the last few years of the record of the successful operation of full scale units of this type at the Manchester Sewage Treatment Works. Because of this interest and at the request of Yeomans Brothers Co., I undertook the study of the relative economies of aeration methods used for activated sludge which is reported here. On the basis of this study it is my contention that both theory and fact strongly support the claims of the proponents of surface aeration, namely, low cost construction, low cost of operation and substantial freedom from maintenance difficulties and that surface aeration should be given serious consideration in the design of sewage treatment plant.

■ AS THE BASIS for estimating the cost of the secondary process of sewage treatment by diffused air, I propose using the data of Schroepfer[1] revised to the year 1949 by Imhoff and Fair and published in

their well-known text book *SEWAGE TREATMENT*, 1956[2].

Herein, "are estimated the cost of aeration tanks, including operating galleries as $1.20 per cu ft of effective capacity, and the cost of power plant, air compressors, sludge pumps, air filters, and other appurtenances for activated sludge plants as $17,000 per mgd capacity." I have adjusted these 1949 figures to 1958 costs by means of the relative value of the *ENGINEERING NEWS-RECORD* Cost of Construction Indexes. The multiplying factor is 1.62.

For my purpose, it is necessary to subdivide the $1.20 figure into the cost of the tank itself, concrete and reinforcing steel, and the cost of air pipes, aeration tile, and other appurtenances peculiar to a diffused air aeration tank (later referred to as "aeration tank equipment"). In order to arrive at a reasonable subdivision into these two categories of the $1.20 figure (adjusted to a 1958 value of $1.94), I have taken advantage of the actual costs from bidding sheets for the plants shown in Table 1. It will be noted that the cost of aeration equipment varies from 14.6 percent through 23 percent to 25.3 percent for the three actual plants shown; therefore, it appears that the value I have adopted as 16.5 percent, which is $0.20 out of a total of $1.20 or $0.32 of a total of $1.94, is not too large. This is the only extension or adjustment of the Schroepfer figures, except for price index and size-factor, that I shall make in my cost analysis.

To repeat, I have assumed that of the $1.20 figure, $1.00 per cu ft was for tank and $0.20 per cu ft was for the other items listed above, included under the $1.20 item. Adjusted to 1958 cost index these cost figures became $1.62; $0.32; and $1.94 respectively. The justification for this apportionment of cost is shown in Table 1, which also contains, for comparison, some actual unit costs of other plants which I have recently obtained from bidding sheets furnished me by the designing engineers and adjusted to 1958 cost index.

It is to be noted that the figures of Schroepfer adjusted for cost index by Imhoff and Fair are for plants of 10 to 100 mgd capacity. The capacity of the other plants is given at the bottom of the table. These unit costs I, myself, have computed from data furnished me by King, of the Metropolitan Sanitary District of Greater Chicago for the West Side plant, and by Hill, of Greeley and Hansen, for the Nassau and North Shore plants.

By comparing the values in the first two lines of Table 1, the reader may decide whether or not those marked with the asterisk are representative. It seems to me that they are. It must be admitted that my computation of unit costs from the data from bidding sheets for the three actual plants listed, is dependent upon the interpretation I made of the meaning of the items listed. However, the reader should be reminded that the only use I am making of these data is in justifying the subdivision of the $1.94 item of Imhoff and Fair table.

In the use of these data in the computations which follow, I will also make use of estimate by Velz of what will be called the plant size factor[3]. They appear in Imhoff and Fair, P. 10[2]. His factor is 1.0 for a one mgd plant, 0.70 for a five mgd plant, and 0.42 for the average of a 10 to 100 mgd plant for which the cost of tank and cost of power plant, blower, etc. in the above table are supposed to apply. How these figures will be used is shown in the following computations.

Yeomans Brothers has supplied, at my request, an estimate of cost of mechanical equipment for surface aeration, as furnished by that Company, of $16,000 per mgd for mechanical equipment for plants of 1 mgd and $14,200 per mgd for plants of 5 mgd or more.

If as a first assumption, I take the costs of the aeration tanks by the diffused air method and by the Hi-Cone surface aeration process to be the same, an estimation of cost may be made for plants of different sizes by the two processes as shown in Table 2.

It may be estimated that diffused aeration tanks, because of their shape and style of construction, require 100 cu yds of concrete per mgd capacity more than do the corresponding tanks using surface aeration, even when holding the same volume of sewage. If we assume that the cost per cu yd of concrete, including steel, formwork, etc., to be $150/cu yd, the additional savings per mgd of the surface aerator over the diffused aeration plant would be about $15,000, increasing the total savings to $62,000 + $15,000 = $77,600 or 33 per cent for a 1 mgd plant; or $223,000 + ($75,000 x 0.70) = $276,000, or 33 per cent for a 5 mgd plant.

Until the high intensity type of surface aeration was developed, it was customary to provide somewhat more volume in aeration tanks by surface aeration than for tanks using diffused air.

As the new equipment came into use, it became evident that aeration times certainly need be no longer—at Manchester they are shorter—than when diffused air is used, and this is the assumption on which the calculations presented in table 2 are based. Since the 1958 Manchester Report has been released, it appears that aeration times for Hi-Cone plants can be very much shorter than formerly, consequently much smaller aeration tanks can be used to treat a given

TABLE I

Costs Adjusted to 1958 Cost Index

	From Fair Adjustment to 1958	North Shore Sanitary District Lake County, Ill.	Nassau Co. Long Island N. Y.	New Battery West Side — Chicago	Hypothetical Plants	
Aeration Tanks (per cu ft)	1.62*	1.46	1.64	1.12		
Aeration Tank Equipment (per cu ft)	0.32* (16.5%)	0.44	0.28	0.38		
Total of above (per cu ft)	1.94	(23.0%)	(14.6%)	(25.3%)		
Power Plant blowers etc. (per mgd)	27,600	1.90	1.92	1.50		
Size of plant (mgd)	10 to 100	47,700	—	—		
Relative cost factor according to Velz for effect of size[3]	0.60 to 0.36 (Ave.-0.42	4.5. 0.72	20 0.52	300 less than 0.36	1 1.00	5 0.70

*Values as adjusted to 1958 cost of construction indexes using data of Schroepfer[1] as revised by Imhoff and Fair.

volume of sewage, with substantial additional savings in the cost of the tanks. The effects of these recently reported improvements have not been taken into consideration in the above computations.

For this reason, the above estimate of 27 percent to 33 percent savings in first cost of plant by the surface aeration process does not appear to be unreasonable for plants of all sizes.

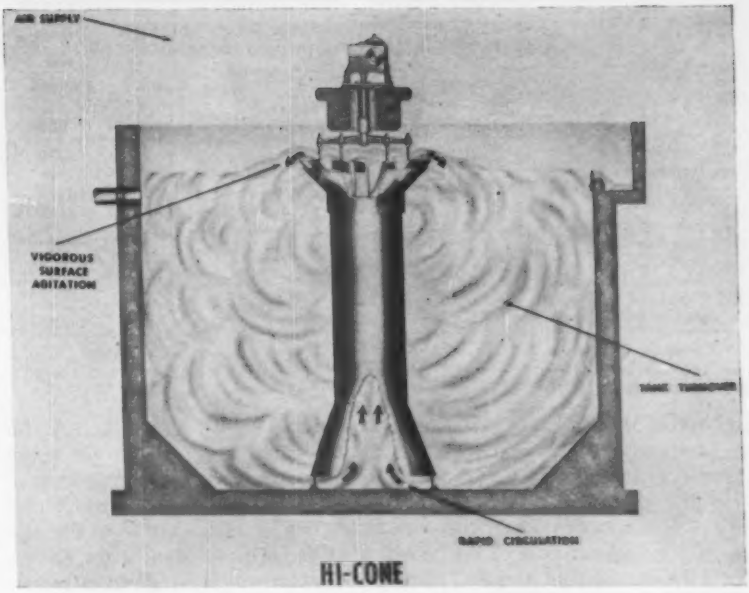
Maintenance Costs

In this area there are available for consideration two facts, one favorable and one unfavorable, to surface aeration, which bear on the question of which type of plant has the advantage in this respect. With the surface aeration, there are several motors to be maintained at the aeration tanks, while in the diffused air plant there are fewer motors of higher horsepower housed in a single building. On the other hand, at a diffused air plant there are spread all over a large number of valves, pipes, meters, and above all, diffusers to be maintained. Diffusers have proved to be a major headache in many plants—a major item of expense—because of their tendency to clog. The expense of cleaning of the air to minimize clogging, and the expense of cleaning or of replacing the diffusers when they do clog, has been considerable.

Cost of Operation

Power is an important item in the cost of operation of an aeration plant, whether of the surface aeration or of the diffused air type. In a student report prepared here at Purdue by Mr. John Bolton in 1951, entitled, "Electrical Power Requirements in Sewage Treatment Processes," Bolton concluded from a study of the literature, that for complete treatment by activated sludge methods, the power required in mechanical aeration plants varied from 1050 to 355 KWH per mil gal, while for diffused air plants, it varied from 1000 to 488 KWH per mil gal. He gives the power requirements as from 0.343 to 0.413 KWH per lb of BOD removed from surface aeration plants but no corresponding figure for diffused air plants. Apparently, he had even more difficulty than I have had now in obtaining these figures for diffused air plants.

Information supplied by King, of the Chicago Sanitary District, shows



CUT AWAY view of Hi Cone Unit

that the diffused aeration plants on the North Side and at Calumet require about 0.40 KWH to remove 1 lb of BOD of settled sewage. In the pamphlet on this subject, published by the Federation of Sewage and Industrial Waste Associations in 1952[3], Table I, page 12, six plants of the mechanical aeration type in the U.S.A. which require lesser power than this in actual operation and eleven which require more power—all of them small plants—are listed.

There is no corresponding table of

TABLE 2
Cost of Diffused Air VS Mechanical Aeration
A. Diffused Air Plant

	1 mgd Size	5 mgd Size
Unit cost of tank (Assumed same for both processes)	Vol. of tank 40,300 cu ft $1.62 x 1.00 / 0.42	201,000 cu ft $1.62 x 0.70 / 0.42
(1) Cost of tank (Assumed same for both processes)	$155,450	$544,000
(2) Unit cost of aeration equipment, etc. for "diffused air plant" cost at $0.32/cu ft	$12,900*	$64,500*
(3) Cost of blower house, etc. for diffusion aeration plant	$27,600 x 1.00 / 0.42 = 65,700	$27,600 x 0.70 / 0.42 x 5 = $230,000
Sum of Items (1), (2), (3)	$234,050	$838,500

**"Velz' plant size factor not applied

B. Mechanical Aeration Plant

	1 mgd plant	5 mgd plant
Cost of mechanical equipment (from Gloppen)	Vol of tank 40,300 cu ft $ 16,000	Vol of tank 201,000 cu ft $ 14,200 x 5 = $71,000
Cost of Tank (as above)	$155,450	$544,000
Total Cost of Mechanical Aeration Plant	$171,450	$615,000
Difference in favor of Mechanical Aeration	**Difference in favor of Mechanical Aeration**	
1 mgd plant	**5 mgd plant**	
$234,050 — $171,450 = $62,000 ($ 62,600 ÷ $234,050) x 100 = 27%	$838,500 — $615,000 = $223,500 ($223,500 ÷ $838,500) x 100 = 28%	

TABLE 3
Operating Data For Simplex Plants

Plant	Average Daily Flow* mgd	BOD mg/l Influent	BOD mg/l Effluent	Aeration period (hrs)	KWH/lb. of BOD removed
Bury	2.729	210	20.0	17.2	.308
Halifax	.850	188	12.8	15.0	.343
Johnstone	1.54	90	9.9	9.6	.247
Bishopbriggs	.50	109	19.3	10.0	.310
Bothwellbank	1.2	123	9.0	11.8	.298
Daldowie	1.7	219	25.0	13.5	.185
East Kilbride	.24	147	13.5	10.0	.322
Glenboig (very small plant)	.06	92	4.1	13.4	.610
Orbiston	1.00	158	14.6	14.0	.286
**Manchester (Davyhulme)	1.237	163	12.7	12.9	.310

* Imperial gallons per 24 hrs.
**Later data indicate improvements (see Table 4), eg in the year 1955 the average of this plant was .245 KWH/lb of BOD

data in this Manual given for diffused air plants; but, it is stated that at Manchester, England, the diffused air requirements were 0.38 KWH per lb of BOD removed while the corresponding requirements of the Simplex Hi-Cone surface aeration plant were 0.35, and of the paddle type 0.55. Since that time, marked improvement of economy has been obtained in the mechanical aeration plant at Manchester, as will be discussed later.

In this pamphlet[5], on page 35, there is a chart of the air requirements of a number of other diffused air plants in the U.S.A. With the exception of two plants, an experimental one of a different depth and one other, all the other plants (eleven in all) used more air than the Chicago Sanitary District plants named on the basis of cu ft of air per lb of BOD applied load. Thus, it seems reasonable to assume that more of these plants were requiring more power per lb of BOD removed than did the Chicago plants named. The present record of performance of surface aerators is very much better than this, and has been for a number of years; and, the performance is steadily improving.

The writer is indebted to Mr. Henry R. King for a table showing the important operation data of 25 surface aeration plants in England. For ten of these plants, the data are so complete that it is possible to compute the KWH requirements for removal of 1 lb of BOD. These are listed in table 3. The plants listed have old style cones—not the high intensity cones which give better results and better economy of air. The data given in Table 3 were obtained in 1946.

It is to be noted from Table 3 that all but one of the plants used considerably less power than do the diffused air plants in the U.S.A. for which data are available to the writer of this report.

The most dramatic and convincing data now available are from the new Hi-Cone plant at Manchester, the results from which are given in the official "Rivers Department Report" of that city[6], [7]. There are four types of activated sludge plants at the Manchester Davyhulme Sewage Works, although only three types were in use when the 1955 Report was published. The three types of plants are operated in parallel treating the same settled sewage. By far, the largest is the diffused air plant.

In the report of 1955[6], it is shown that the Simplex plant required less power to provide a better effluent than either of the other plants. The results are shown in Table 4. I have computed the values for power in column 3.

The power requirements of the Simplex plant were then only 61.0 percent as much as are those of the Chicago Sanitary District plants on a comparable basis. It is also to be noted that both power and the time used for aeration in the Simplex plant were very much less than in either of the other two processes employed at Manchester.

Low as these power requirements quite evidently are, the new data on

TABLE 4
Manchester, England, Sewage Treatment Works
1955

	Effluent mg/e BOD	Effluent mg/e susp. matter	KWH/lb BOD removed	Aeration Period (hours)
Sheffield Plant	22.7	19	0.336	20.1
Simplex Plant	18.1	17	0.244	9.6
Diffused Air Plant	24.4	23.7	0.444	14.2

the operation of the high intensity cone at Manchester, England, just released[7], is much more striking, much more indicative of the economic potentialities of this mode of sewage aeration. In the Report for the year ending March 31, 1958[7] of the Rivers Department of the City of Manchester, are shown the relative power requirements and aeration time periods of several schemes of aeration. The diffused air plant, as judged by data for Units 1 and 2, retaining the sewage an average of 7.95 hours, has required an average of 0.40 KWH per lb. of BOD removed[8]. One of the modified Hi-Cone units attained equally good results with a power requirement of only 0.332 KWH per lb of BOD removed, and with the aeration period reduced to 2.22 hours and later with a power requirement of only 0.241 KWH per lb of BOD removed in 3.16 hours. This unit is still being modified and preliminary indications are that already still greater efficiency is being attained.

Thus, it would appear that a great increase in economy of construction of tanks as well as of power requirements has already been attained in this process.

A summary of results of three years of operation of the Manchester plant, recently supplied me shows that the Hi-Cone plant with 6.5 hours retention has the lowest total cost of the six plants on a mil gal basis.

Surface Aeration Theory

The question arises: How is it possible that surface aeration can accomplish the desired degree of purification of sewage in so short a period of time or in tanks of such small volume and with so small an expenditure of energy? Or to put the matter a little differently, is is reasonable to expect these results? It seems to me that it is.

First, it is not surprising that the activated sludge process using surface aeration has been and may be further greatly speeded up. Analysis of the performance of trickling filters shows that the actual transfer of the organic ingredients of settled sewage to the living slimes on the stones of the filter is accomplished in a matter of seconds—at the most in a couple of minutes. Might not the corresponding transfer of organic matter to the floating, living activated sludge in an aeration tank also be accomplished in a correspondingly short period of time?

This is not to deny that much longer time is required to oxidize the material after it has been adsorbed by the slime or floating sludge. In the filter, the slime remains on the stones where it is continuously oxidized; in the aeration tank the corresponding activated sludge may be returned or retained for as long a time as is desired by appropriately increasing the concentration of solids in the aeration tank, providing that sufficient oxygen is supplied to the sludge. It is apparent that sufficient oxygen was supplied in the process discussed in this paper.

The next consideration, then, is what is the secret of the success of the aeration oxygen supply phase of the process? I believe this to reside in the rapid creation of new air-water surfaces at the tank surface and the effective dispersal of the oxygen-rich water, enclosing these surfaces, throughout the body of the tank. To explain more fully why I believe this action is of importance, it is necessary to set forth in somewhat greater detail the concept of aeration which I have obtained, mainly from the papers of Dobbins[9], [10], and of Pasveer [11], [12].

When a new quiescent water or sewage surface deficient in oxygen is suddenly exposed to the air or to pure oxygen, the instantaneous initial rate of absorption is extremely high and rapidly diminishes at a rate inversely proportional to the square root of time measured from the instant of initial exposure.

Pasveer writes: "It follows . . . that the energy employed for aeration should be directed toward the creation of a new water-air interfacial surface."

I would add that the persistence of this interfacial surface while the rate of diffusion is rapidly diminishing with time is much less important than the creation of fresh new surfaces.

So long as we are dealing with such rapidly produced new surfaces and we are still in the range of the law stated above, it can easily be shown that the rate of aeration—of introduction of oxygen into the liquid—varies with the square root of the rate of production of new surface. This statement may be confirmed by a formula from an article by Dobbins [10], where he states that K_L is proportional to D_r, where D is the fixed diffusion constant of the gas and r is the rate of displacement of film surface. K_L is a factor whose variation determines the variation in the rate of admission of oxygen into the liquid film. It is the so-called liquid film coefficient. In air bubble aeration, the rate of diffusion is very high at the instant of formation of the bubble but appears to diminish toward the low value determined by the steady diffusion rate through a film of substantially constant thickness. For the greater part of the time that the bubble is rising through the tank, the rate of diffusion approaches this exceedingly low value.

HI CONE unit in operation

Both theory and experiment indicate that it is the rapid creation of fresh new air-water surfaces that should be depended upon to introduce the oxygen to the liquid rather than the maintenance for a long period of time of a body of air (as in a bubble) in contact with the water. It is easy to show that the energy required for new air-water surfaces is insignificantly small; that is to say, the surface energy of the film is very small, even when created as a bubble.

A careful analysis of the results of tests of submerged porous tile performed by the writer for the Sanitary District of Chicago in 1925 clearly indicates that the pressure required for creation of air-water surfaces was no more than the ⅔ ft. of water and probably less. Thus, in a 15-ft. deep aeration tank, no more than 4 per cent of the energy expended in compressing the air is employed in creating the air-water surface.

The general theory set forth above as applied to air bubbles is confirmed by the experiments of Carver who writes, "The transfer coefficient (of oxygen from rising bubbles into water) was found to increase with decreasing column height."[13]

Kountz writes, "In all of the aerators the bulk of the oxygen solution occurs at the instant of creating the interface. The oxygen solution which occurs while the bubble rises and breaks the surface is a minor portion of the total, probably less than 20 per cent"[14].

Mr. S. W. Freese expressed somewhat the same opinion as early as 1937. He writes [15]: . . . "the bubbles rising through the liquid are enveloped in a surface tension film, including some colloidal matter (which film interferes with the passage of oxygen into the liquid at least until the bubble reaches the surface of the liquid . . ."

"In a series of experiments conducted by the writer in 1925, nitrogen and air (also oxygen and carbon dioxide) were used in parallel for agitation of the mixed liquor—(under comparable conditions). The air and inert gas gave practically the same results."

Hussey, concluded in 1948 that,

"Available evidence suggests the presence of a liquid film carried up-

ward by the bubble. This conclusion follows from the observation that at the end of each run by carefully titrating the sulfite concentration in successive horizontal layers of solution a concentration gradient was discovered, showing a consistently larger amount of oxygen absorbed by the higher layers" [16].

Thus, I am inclined to believe that the egg-beater action at the surface of the tank rapidly folds, so to speak, new air-water surfaces into the upper layers of tank liquid at little cost of energy, especially in the Hi-Cone designs. I believe that the greater part of the energy consumed in this process goes for mixing. The oxygen-rich water of the upper layer of the tank is mixed with the lower layers, the activated sludge is brought into contact with this high oxygen containing water and with the organic ingredients of the sewage at the same time.

The air lift as a method of pumping is recognized to be relatively inefficent as compared to mechanical pumps; furthermore, the conversion of mechanical power to hydraulic power in an air-compressor is inherently inefficient. It does not, therefore, seem surprising that mechanical methods should prove to be more economical than diffused air methods for creating the velocities needed in an aerobic tank for mixing and for preventing deposits.

Furthermore, it seems quite reasonable to suppose that by shortening the period of retention in the aeration tank, the energy required for mixing should be reduced. Thus, as improvements have been and doubtless will continue to be made in the process of creating new air-water surfaces, and thus in enriching the oxygen content of the tanks, the solids concentrations have been and will continue to be increased, and the process may ultimately approach the almost instantaneous purifying action of a trickling filter—without requiring the open stone bed with its attendant nuisance and other aesthetic disadvantages.

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Device To Cut Sewer Cleaning Costs

Necessity is the mother of invention.

And for the Salt Lake Suburban Sanitary District, a little invention is going a long way.

Inventive minds of two district officials will save patrons an estimated more than half the costs of preventive maintenance oprations in cleaning sewer lines.

A specially manufactured grooved rubber ball, the same size as the sewer line diameter, is introduced at one point into the line.

Water pressure builds up behind the ball thus forcing it through the line, clearing all obstructions in its path. A long rope is attached to the ball and has formerly been pulled back through the line by hand

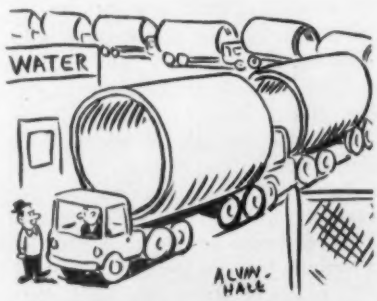
The new system, which enables half the number of crewmen to clean twice the length of line in less than average time, engages an engine, pulleys and gears to return the ball and rewind 500 feet of nylon rope.

Mr. South, manager, said he got the idea watching telephone maintenance crews pull cable through underground conduits with power units. Emil Meyers, treatment plant superintendent, put the idea into working form.

"Our new system doubles the capacity of a crew. In California a crew cleans on an average of 1,500 feet per day. With our mechanization, we can do 3,000 feet with half the men formerly used," he explained.

Cost of this preventive maintenance program around the nation averages between $100 and $200 per mile. Salt Lake Suburban District now can carry on such work, for between $60 and $75 per mile, Mr. South said.

Regular telephone communication between street entrances to the sewer and the standard set of rods are also employed. All these facilities have been attached to a small trailer specially built for the district.



You misread my order. It was for 120 ten inch pipes, not ten 120 inch pipes.

Chemical Treatment for Water Clarification requires an understanding of . . .

Coagulants, *their selection.*

PART II

by MARVIN LANE, Technical Manager,
Graver Water Conditioning Co.,
New York, N. Y.

EDITOR'S NOTE: Part I discussed the theory of coagulation. Here the selection of coagulants will be reviewed. Part III of this three-part series will concern the method for determining the proper conditions for coagulation treatment. The series objective is to provide a better understanding of chemical treatment for water clarification.

■ SEVEN CHEMICALS and chemical combinations are used for coagulation in the treatment of water supplies. Table 3 lists these coagulants and gives useful information for the selection and operation of the clarification equipment. The characteristics of these coagulants are described below.

Alum

Alum is by far the most commonly used coagulant, both for color and turbidity reduction as well as for water softening with lime and soda ash. It is readily soluble in water and has little tendency to cake. It is effective on the highly colored, low turbidity waters of New England and of the South, as well as on many highly turbid, low color supplies. Normally, alum is the first coagulant tried in "Jar Test" work. Its pH range is 5.5 to 8.0 for clarification and 9 to 10.5 for softening.

Ferric Sulfate

Ferric sulfate is frequently superior to alum on highly turbid waters and in softening applications. It does well in the higher pH ranges from 8 to 11, but sometimes is effective in the range of 5 to 6 for color reduction. When effective, it tends to form a denser, faster settling floc than alum. It is a little more difficult to dissolve and has more insolubles than alum, but neither of these is a serious limitation in properly designed feeding equipment. It is much more corrosive to steel and brass than alum and even attacks some stainless alloys. Non-metallic materials are best for handling ferric sulfate solution.

Ferrous Sulfate (Copperas)

Ferrous sulfate has been in use for many years and is growing steadily in popularity. It is handled exactly the same as alum. In aerated supplies, the ferrous hydroxide formed is oxidized to ferric hydroxide. However, on non-aerated supplies or on heavily contaminated waters, this oxidation may not take place and a bluish-green floc and sludge may be obtained. Like ferric sulfate, ferrous sulfate is most frequently effective in the higher pH range on turbid waters and in conjunction with the precipitates of calcium carbonate and magnesium hydroxide in softening treatments. In addition, copperas reduces hydrogen sulfide effectively and, in conjunction with chlorine, can completely eliminate the hydrogen sulfide odor present in many well water supplies.

Chlorinated copperas ($FeSO_4.FeCl_3$) produced by mixing chlorine and copperas is used in some applications.

Ferric Chloride

Ferric chloride is not used much in water treatment, but is widely used in waste and sewage clarification where it is often more effective than alum or the other iron coagulants. It is highly corrosive and best handled in non-metallic materials.

Sodium Aluminate

Used alone, sodium aluminate is most frequently applied in softening. It is alkaline and can be fed with caustic or lime in plain steel tanks. For small plants, it can eliminate the need for a separate coagulant feeder. Although soluble at high pH, in the presence of calcium and magnesium ions it forms very insoluble salts so that aluminum in the treated water is practically undetectable.

The price per pound for sodium aluminate is considerably higher than for the acid coagulants, but since the alumina content is about three times that of filter slum, the cost per pound of alumina is very nearly the same. Particularly if the cost of the alkali required for the acid coagulant is considered.

Alum and Sodium Aluminate

The combination of alum and aluminate, fed separately, is very effective on many water supplies[1]. The alkalinity supplied by the aluminate may eliminate the need for separate alkali feeding for pH adjustment. It is not unusual to find that coagulation and floc quality are better with the use of the two coagulants than using the same equivalent dosage of either one separately at the same adjusted pH.

Alum and Copperas

Alum and copperas is another combination of coagulants used effectively on some water supplies. It is used seasonally at New Orleans for the Mississippi River Source giving more complete clarification and better floc than either coagulant alone.

Table 3 Coagulants

CHEMICAL FORMULA COMMON NAME USE	AVAILABLE FORMS	SHIPPING DATA CONTAINERS and REQUIREMENTS	APPEARANCE and PROPERTIES	WEIGHT lb/cu ft (Bulk Density)	CHARACTERISTICS COMMERCIAL STRENGTH	SOLUBILITY IN WATER gm/100 ml	BEST FEEDING FORM	CHEMICAL TO WATER RATIO FOR CONTINUOUS DISSOLVING	TYPES OF FEEDERS	ACCESSORY EQUIPMENT REQUIRED	SUITABLE HANDLING MATERIALS
ALUMINUM SULFATE $Al_2(SO_4)_3.14N_2O$ (Approx) (Alum., Filter Alum, Pickle Alum, Sulfate of Alumina) Coagulation of pH 5.5 to 8.0, sludge conditioning	Ground Rice Powder Lump	Bags--100, 200 lb Bbl--325 400 lb Drums-25 100, 250 lb Bulk--C/L	Light tan to gray-green Dusty astringent Only slightly hygroscopic 1% Soln-pH 3.4	60 to 75 (Powder is lighter) To calculate hopper capacities use 60	17% Al_2O_3	60.0 @ 0°C 65.3 @ 10°C 71.0 @ 20°C 78.8 @ 20°C	Ground or Rice about 60 lb/cu ft Powder is very dusty, arches in hoppers and in troublesome	0.5 lb/gal--Max Dissolver detention time 5 min--Min	Dry or Solution	Dissolver Scales for volumetric feeders Dust Collector	DRY Iron, steel, concrete WET Lead, rubber, Duriron, asphalt, cypress, stainless steel type 316
ALUM, LIQUID $Al_2(SO_4)_3.XN_2O$ (Liquid Alum) 1 gal 32.2° Be = 4.5 lb Dry Alum Coagulation at pH 5.5 to 8.0, sludge conditioner.	Solution 27° Be 32.2° Be 36.4° Be	Manufactured near site 4000-8000 gal steel T/C 2000-4000 gal rubber lined steel tank trucks High freight cost precludes distant shipment.	Light green to light brown solution 1% Soln-pH 3.4	At 60°F 32.2 Be Spec. Grav. 1.285 10.7lb/gal	27° Be 5.8% Al_2O_3 32° Be 7.2% Al_2O_3 37.5° Be 8.5% Al_2O_3	Completely miscible	Full strength under controlled temperature or dilute to avoid crystallization	Dilute to 3% soln concentration before applying to water; i.e. add 1 gal to 17 gal N_2O	Solution	Tank gauges or scales Transfer pumps Storage Tank Temperature Control Eductor or dissolvers for dilution	Lead or rubber lined tanks, Duriron; Ward rubber or plastic pipe
FERRIC CHLORIDE $FeCl_3$--Anhydrous $FeCl_3.6N_2O$--Crystal $FeCl_3$--Solution (Ferrichlor, Chloride of Iron) Coagulation sludge conditioning	Solution Lumps--sticks (Crystal) Granules	Solution Carboys--5,13 gal Truck, T/C Crystal Keg--100, 400, 450 lb Drums--150, 350, 630 Lb	Solution--Dark brown syrup Crystals--Yellow brown lumps Anhydrous--Green Black Hygroscopic, staining corrosive in liquid form	Solution 11.2 to 12.4 lb/gal Crystal 60 to 64 Anhydrous 85 to 90	Solution 35 to 45% $FeCl_3$ Crystal 60% $FeCl_3$ Anhydrous 96 to 97% $FeCl_3$	Solution completely Crystal 64.4 @ 10°C 91.1 @ 20°C Anhydrous 74.4 @ 0°C	Solution or any dilution up to 45% $FeCl_3$ Content	Anhydrous to form 45%--6.75lb/gal 40%--5.55lb/gal 35%--4.50lb/gal 30%--3.73lb/gal 20%--2.06lb/gal 10%--927lb/gal (Multiply $FeCl_3$ by 1.666 to obtain $FeCl_3.6N_2O$)	Solution	Storage tanks for liquid Dissolving tanks for lumps or granules	Rubber, glass ceramics, plastics
FERRIC SULFATE $Fe_2(SO_4)_3.2N_2O$ (Ferrifloc) $Fe_2(SO_4)_3.2N_2O$ (Ferriclear) (Iron Sulfate) Coagulation	Granules	Bags--100 lb Drums--400 425 lb Bulk--C/L	With 2 N_2O Red brown With 3N_2O Red gray Mildy hygroscopic corrosive in solution. Store dry in tight containers Stains	70 to 72	3 N_2O 68%$Fe_2(SO_4)_3$ 2N_2O 76%$Fe_2(SO_4)_3$ 21%Fe	Very soluble	Granules	2 lb/Gal (Range 1.4 to 2.4 lb/gal) for 20 min detention. (Warm water permits shorter detention)	Dry or Solution	Dissolver with motor driven mixer and water control Vapor remover solution tank	Stainless steel 316, rubber, lead, ceramics, Duriron,
FERROUS SULFATE $FeSO_4.7N_2O$ (Copperas Iron Sulfate, Sugar Sulfate, Green Vitriol) Coagulation	Granules Crystals Powder Lumps	Bags--100 lb Bbl--400 lb Bulk	Green to brownish yellow Cakes in storage above 20°C Stains store dry in tight containers (Add $CaSO_4$ to keep free-flowing)	63 to 66	55%$FeSO_4$ 20%Fe	28.7 @ 0°C 37.5 @ 10°C 48.5 @ 20°C 60.2 @ 30°C	Granules	0.5 lb/gal (Dissolver dention time 5 min.--minimum)	GRAVIMETRIC Loss-InWeight Up to 2000 lb/hr Belt-- Up to 10,000 lb/hr VOLTMETRIC Universal-- Up to 6000 lb/hr	Dissolvers Scales	DRY Iron, steel, concrete WET Lead, rubber, from asphalt, cypress, stainless steel
SODIUM ALUMINATE $Na_2Al_2O_4$ (Soda Alum) Ratio Na_2O/ Al_2O_3 1/1 or 1 15/1 (high parity) Coagulation	Ground (Pulverized) Crystals Liquid 27° Be	Ground Bags--50, 100 lb Drums Liquid Drums	High Purity White Standard Gray Hygroscopic alkaline	High Purity 50 Standard 60	High Purity Al_2O_3 45% $Na_2Al_2O_4$ 72% Standard Al_2O_3 55% $Na_2Al_2O_4$ 88-90%	High Purity 80 Standard 6-8% Insolubles	Granular or Solution as received Std. grade produces sludge on dissolving	Dry 0.5 lb/gal) Solution Dilute as desired	Dry or Solution	Hopper agitator for dry form	DRY or LIQUID Iron, steel, concrete, ceramics, rubber, plastics

Selecting The Coagulant

Limitations

In some plants the use of either the aluminum or iron containing coagulants may be ruled out on the basis of limitations of the product or process in which the water is used. Iron coagulants are much more frequently objected to than aluminum. In the paper and textile industries, for instance, both of which require large volumes of clarified water, the chance of having any iron in the water, because of improper application of the treatment or mechanical failure, almost always preclude its use. It is usually not the normal iron content of these coagulated supplies which is objectionable, but rather the possibility of high concentrations due to accidental causes.

Aluminum coagulants are sometimes objected to on the ground that any increase in aluminum concentration in the water might lead to the formation of analcite scales in the boilers. This is not a common objection but does occur in some applications. It is usually possible to work out a treatment with careful pH control which will keep the aluminum concentration in the filtered water down to very low values. If the optimum pH does not coincide with the pH of minimum aluminum solubility, the use of a coagulant aid will broaden the optimum pH range and permit operating successfully at the required pH for minimum aluminum concentration.

This has been done successfully on a plant treating a shallow lake-water supply fed from the Delaware River where alum is the only coagulant which produces a completely satisfactory finished water and a sufficiently dense floc for high rate operation. In this case, the feeding of 2 mg/L of activated silica permitted reduction of the pH to 6.8 (instead of 7.3 to 7.5), which on this water was the pH required for minimum aluminum concentration.

Experience of Neighboring Plants

It is frequently possible to obtain valuable information on the best coagulant to use, as well as the other chemical treatment conditions required, from neighboring industrial and municipal clarification plants treating the same water supply. Of particular value is the experience of these plants with changing water conditions seasonally or even daily. Heavy rainfalls usually change the coagulating characteristics of surface or shallow well supplies.

During the early operation of any clarification plant, it is necessary to learn the treatment changes required to cope with the changing water conditions. Such information obtained from existing plants can facilitate operation of a new plant and reduce the amount of operating attention. Although it is best to discuss these matters directly with the operating personnel, useful information can frequently be found in the literature. Other sources of information on operation experiences are the consulting engineers and clarification equipment manufacturers who have accumulated chemical treatment data from the major surface water supplies over the years.

Other Factors

In evalulating information obtained from operating plants and in attempting to apply it to new plants, it is necessary to take into consideration any differences which may exist between the two. The first point of difference may be in the raw water. Even though two plants may be located on the same river in the same city, the coagulating characteristics of the water may be different. For example, a creek entering the river between the two plants may affect the quality of water at the intake of the downstream plant. Wastes entering the river from the upstream plant or from a city sewer line can also change the water coagulating characteristics markedly. Even temperature variations large enough to affect the operation of sedimentation equipment may be encountered when large plants with once-through cooling systems are located upstream on small or slow flowing streams.

Ultimate Use

The question of treated water quality must be considered. A plant clarifying water for cooling tower makeup use may not require the color reduction that a neighboring plant may need for their process applications. Similarly, a plant treating mainly for boiler feedwater use and producing an acceptable water may not be suitable for cellulose fiber production or fine chemical manufacturing.

Equipment

Finally, differences in the design of the clarification plant equipment should be taken into account[2]. For example, the chemical treatment used on a conventional type municipal plant with 4 to 6 hours retention may not be suitable for an adjacent plant using high-rate upflow units.

Aside from such considerations as these, the selection of the coagulant as well as the other treatment reagents should be determined by Jar Testing first and ultimately by the result obtained in the plant equipment.

Jar Testing will be discussed in Part III of this series of articles on coagulation.

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Oxygen Relationships in Streams

Oxygen Relationships in Streams is the title of a technical report W58-2 of the Robert A. Taft Sanitary Engineering Center and is a 194-page volume which contains the proceedings of a seminar sponsored by the water supply and water pollution program of the Center. The report is dedicated to Harold W. Streeter, a PHS sanitary engineer, now retired who pioneered in developing methods of computing stream oxygen conditions.

Topics of the report include the use of stream data in the administration of pollution abatement programs, dissolved oxygen requirements for fishes, the oxygen sag equations, measurement and calculation of stream reaeration ratio, significance of organic sludge deposits, a report of a Thames Estuary study, mixing and diffusion of wastes in streams, effects of impoundments on oxygen resources, sampling and analytical methods in stream studies, application of stream data to waste treatment design, and the effects of algae on dissolved oxygen and biochemical oxygen demand.

The report is an excellent composite on the subject of oxygen relationships in streams and the ability of surface waters to receive waste waters.

A brief discourse on the basic ingredients, and their application to a successful . . .

Public Relations Program

by J. E. MEERS, Superintendent, Sanitary District for Bloom Township, Chicago Heights, Illinois

■ PUBLIC RELATIONS today has come a long way from the old days of horn blowing publicity stunts. It might be said, the public expects more maturity and responsibility.

We may ask, what is public relations? It can be termed a combination of education, service, useful information, action and words, backed by deeds. It is often described as, "Giving good service and getting credit for it." Usually, it is anything that may be used to present your case before the public in a manner to win its approval—a form of lobbying to obtain support for your organization. Public relations includes any form of advertising, exhibits, or speaking.

Why do we, in our particular work, need a public relations program? First, it will get people to take a greater interest in all sanitary facilities of our community. A well informed and interested public will approve needed projects more readily than an uninformed group. Operators will improve their standing in the community, if the people know why they have or need a sewage treatment plant; what it does and how; what it takes to maintain it. Without knowledge and interest in what you do, most people class anyone working with sewage in the lowest strata of society. Operators can remedy this misconception by maintaining a good public relations program. Knowledge begets interest!

How can public relations pay off? Good public relations between the operator and local administration pay off in being able to get help when it is needed; it helps get sufficient funds to operate the plant and adds to your prestige with your superiors and often, a better salary. Good public relations with the community pays off in a better understanding, better prestige and support when improvements are necessary. It has been proven that bond issues for any type of municipal work will be approved if there has been a good public relations, educational and promotional program.

What sort of information does the public want to know? Many times it depends what the problem and needs may be at the time. Also, it could depend on the locality. Each program has to be geared to the need, the resources at hand, and the community you serve. The treatment plant can be a source of information and practical interest to the public. This includes the historical background of your plant; how and when it was built; why it was built and the people responsible for its being built. Such topics as the utilization of sewage gas as a source of power and heat, and the utilization of sewage sludge as fertilizer are of interest to the public. Give facts about the effect a clean or polluted stream has on the community. If the streams in your area are polluted, know the source, how, what, when and where the pollution occurs. If your plant is a source of pollution, know all the facts. A knowledge of the sewer system in your community can be a valuable aid to any public relations program. Keep an accurate, up-to-date record of the location, size and adequacy of the sewers readily available. This information can certainly be time saving and you can perform a worthwhile service to contractors, commercial firms, industries and the public in general.

What are some of the phases of a public relations program and who are some of the people you must deal with? The operator should make every effort to cooperate with his municipal officials—usually they are his

Communication Outlets

Medium	Type of Information
Newspapers	News Stories Feature Articles Editorials Photographs Paid Advertisements
Printed Material	Folders Brochures Letters
Displays	Posters Billboards Auto Bumper Strips Car Cards
Radio and Television	News coverage Talks and interviews Station break announcements
Lectures	
Inspection trips	
Motion Pictures	

The Five "W's" of Public Relations

1. What	covers the nature of a problem as seen through the eyes of those closest to it, including facts and opinions with a bearing on the problem.
2. Who	gets into the subject of the individuals for whom you work and the public you want to influence.
3. When	involves historical background and timing.
4. Where	brings out facts of location and the community or communities affected.
5. Why	calls for reasons leading up to current problem.

superiors. He should schedule periodic group visits for the officials and other utility people. The operator should submit brief monthly reports of the plant operations to his superiors in person. He should submit an annual report listing his activities, a summary of operation data, expenses incurred, costs and figures, and recommendations for improvements and anything else of value. His reports should be brief and factual.

Also, the operator should work closely with school officials and teachers. He could invite high school, college and university groups to tour his plant and encourage contests for school groups in the form of posters, essays, etc.

Operators should encourage service clubs and similar organizations to visit his plant in groups. He should be prepared to give talks and/or supply materials and information, such as movies, on sewage treatment and clean streams.

The most important group he should keep in touch with at all times is the public in general. He will have to exploit to full advantage all means of modern communications. The importance of a program will depend largely on the type of communications needed.

You may keep this in mind, "Good performance plus good communications equals good public relations." Also, each program should have a theme or slogan such as, "Clean Water is everybody's responsibility" or, "Those that pollute should purify." Seek the aid of your newspapers, radio and television writers; they usually can come up with some very good ideas.

How, then, can I prepare a public relations program? The first thing to remember is the five "W's"—What, Who, When, Where and Why!

Certainly, the local situation will dictate the type of program needed. Make an analysis of your problem and formulate the strategy, theme and devices to be used. Consider the novelty, timing, personnel, needs and limitations. Attention should be given to defining and understanding your public and the best media for reaching it. Consider the advisability of appointing citizen's committees. Always keep alert to new ideas, trends, changes and opportunities.

Try to foresee how the things you do or say, will look or sound, several years hence. Good public relations is not here today and gone tomorrow. Maintain a service attitude and ask yourself, "Can I be helpful or useful?"

You may find dozens of helpful definitions for public relations, but for our purpose the heart of them consists of, live right and be understood, and deserve good will before trying to win public understanding and approval.

Sources:

Publications: ***U. S. Public Health Service;*** **"Clean Water is Everybody's Business", "Kit of Materials", etc.**
General Electric Co.; **"Good Water and Plenty of It", "Clean Water and How to Get It."**
Clay Product's Assn.; **"Untreated Sewage Endangers Us All", "New Sewers", etc.**

Posters: ***U. S. Public Health Service;*** **"Conserve our Water Resources Through Pollution Control", "Help Fight Pollution Now."**

Films: ***U. S. Public Health Service or State Health Departments;*** **"Clean Water", and many others mostly 16 mm with color and sound.**

There are many other publications, posters and films available through the various manufacturing companies. Trade associations are also good sources of supply.

The Seven Keys to a Successful Public Relations Program

1. Think of others first	It is well to remember that you are working with other people and are dependent on others.
2. Be Concise	Be able to communicate well—give explicit instructions.
3. Be Sincere	Whatever you do—do your best.
4. Don't promise more than you can deliver	Know your limitations and those of others.
5. Recognize good work of others	No matter how bad a person is, there is always good can be found with little effort on your part.
6. Be a good listener	You can't learn by hearing yourself talk—it pays to listen.
7. Don't argue	Argument leads to anger and then your case is lost.

Valuable information for those in the design and operation of water and sewage plants is contained in . . .

Valve Selection
for Water and Sewage Service

by H. H. BENJES, Department Head
Black & Veatch
Consulting Engineers
Kansas City, Mo.

EDITOR'S NOTE: Mr. Benjes in his paper presented at and published with the permission of the Ninth Annual Sanitary Engineering Conference, University of Kansas develops a thorough discussion of the types of valves available and the factors which influence the determination of which of those available is most applicable in a particular case. The information developed on sizing of operators for butterfly valves could result in reducing considerable expenditures for these items.

■ THE PURPOSE of installing any valve is to stop or permit flow, to prevent reverse flow, to regulate or limit flow, or to perform some combination of these functions. The selection of the best valve to perform dependably and satisfactorily under all conditions involves a number of considerations, many of which are complex problems requiring for their correct solution broad knowledge, experience, and judgment on the part of the engineer. If the best valve for the service is to be selected, the engineer must be versed in not only the fields of hydraulics, mechanics, and materials, but he most also be familiar with all of the different valve types and the many variations in construction details and combinations of materials available from manufacturers.

Not too many years ago the gate valve and the swing check valve, both of cast iron or cast steel construction with bronze trim, were the only kinds of valves in common usage in the water and sewage works industries. This situation has changed; today the designers of water or sewage works can, and do, choose from almost countless combinations of materials and types when selecting a valve for a particular service. This is progress and has resulted in dependable, properly functioning valve installations when proper selections have been made. A greater responsibility, however, is now placed upon the engineer to select the best valve for any given combination of circumstances.

This paper will not attempt to give a simple prescription or formula for selecting valves. It will, rather, outline some of the factors and considerations which should be studied and weighed carefully by the designer before making any valve selection. The discussion will be limited to valves commonly used in water and sewage works.

Basic Considerations

Type and Temperature of Fluid (or Gas) to be Handled

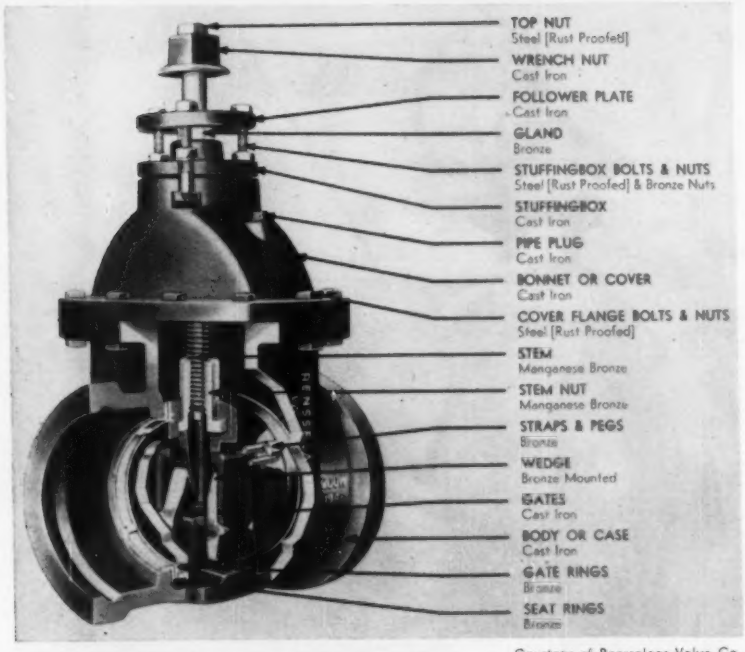
The type and temperature of the fluid to be handled affects not only the type of valve to be selected, but also the materials of construction. In sewage work where stringy materials are encountered, the valve should not have projections into the flow on which material can hang-up. If suspended solids of an abrasive nature are to be encountered, the materials used in the construction of the valve should be abrasion resistant; likewise, corrosion resistant materials are required where corrosive fluids are to be encountered. Although temperature ordinarily is not a factor in selecting valves for water and sewage works, it sometimes becomes a factor when valves are to be used with auxiliary equipment such as heating boilers or carbon dioxide generators. The designer should make certain that the valve selected is suitable for the operating temperature; valves used for water and sewage service are not suitable for high temperatures.

Function

The function of the valve is a primary consideration; if the valve does not perform in the manner intended, the basic reason for installing the valve is defeated. All types of valves are not suitable for all applications and the designer must inform himself as to the best type of valve to fit a particular situation.

Flow Range

It is necessary to know only the normal and maximum flow when selecting a valve for stop or check service whereas the selection of regulating valves requires the determination of the complete range of flow from minimum to maximum if proper regulation is to be obtained. Most regulating valves have a limited range of flow within which they can perform satisfactorily. If extremely



Courtesy of Rensselaer Valve Co.

Fig. 1 STANDARD DOUBLE-Disk Gate Valve

wide ranges of flow are to be regulated, more than one valve may be required.

Pressures

Both the normal and maximum pressures to which the valve will be subjected must be determined accurately with the valve in the opened and closed positions. The maximum pressure is usually the governing factor as the valve must be capable of withstanding the maximum pressure, infrequently though it may occur, without failure or excessive distortion.

Hydraulic Characteristics

The transient effects upon a system when changing, starting, or stopping the flow can result in excessive surges and consequent pipeline failures if valve characteristics are not coordinated with system characteristics to control pressure surges.

Operation

Whether the valve should be manually operated, power operated but manually controlled, or completely automatic, is dependent almost entirely upon the function the valve is to perform and the effort required for operation. Power operators should be provided for large or high pressure valves which require excessive effort for operation and for valves which must be operated from a remote location. Regulating valves must, almost of necessity, be power operated to perform their intended function. The type of operator selected, and whether the operating energy is hydraulic, pneumatic or electric, will depend on many factors and should be studied carefully.

Frequency of Operation

The frequency of operation will determine not only the type of valve selected, but also the materials to be used in its construction. Frequent operation entails wear of moving and sliding parts. Sliding parts are particularly vulnerable to wear and should be avoided in the selection of valves operated frequently.

Reliability

The reliability required in a valve is largely dependent upon its importance to the system in which it is installed. Less reliability is required in a valve installed where only a small part of a system would be affected if the valve fails or cannot be operated than for a valve installed where a similar occurrence would involve a shut-down of a major part of a system. Costs become of secondary or no importance when selecting a valve in the latter category as the consequential damages of a major system shutdown cannot be evaluated from a monetary standpoint.

Economics

The relative economics of the various types and sizes of valves which may be considered for a particular application should be studied before making the final selection. Economic studies should include the initial cost of the installation, the evaluated cost of pumping against the head loss through the valve, maintenance, and obsolescence. Economics alone should never be the controlling factor in the selection of a valve, but should be considered only after other requirements have been satisfied.

Ambient Conditions

Whether the valve is buried, submerged, or located in a structure will determine not only the type of valve, but also its construction. Valves for direct-burial or subject to submergence require water-tight gear cases, corrosion resistant bodies and operator enclosures, and freedom from maintenance.

It would be difficult to select one, or several, of the factors listed above as being more important than others under any given set of circumstances. All of the factors listed must be weighed in the order of their importance for the particular application. Only then, can the proper selection be made.

Basic Valve Types

There are four basic types of valves: (1) globe, (2) slide or gate, (3) rotary, and (4) swing. Globe valves are probably the most frequently used valves because plumbing fixtures are ordinarily furnished with valves of this type. Globe valves may be either of the straight or angle type with the seats parallel to the flow in the straight-through type and normal and against the flow in the angle type. The most common type of slide valve is the gate valve so commonly used for shut-off in water distribution systems. Rotary valves include stop cocks, plug valves, cone valves, spherical (ball) valves, and butterfly valves. Swing valves are used to prevent reversal of flow and are characterized as being piv-

oted so that flow can occur in one direction, but not in the other. The ordinary swing check valve is of this type.

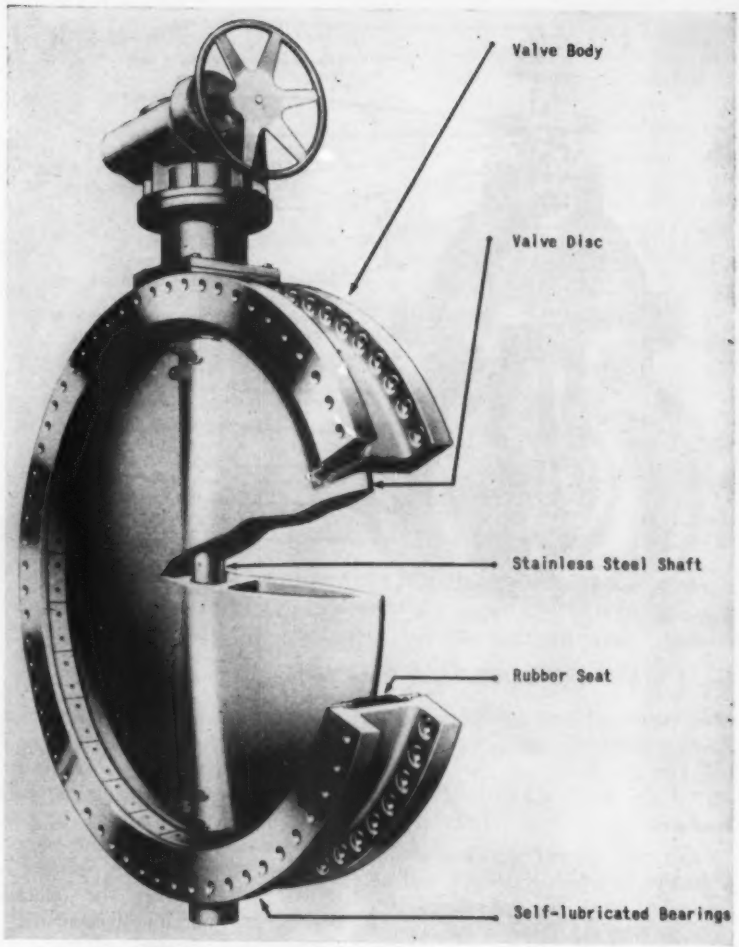
All of the types mentioned are commonly used in water and sewage works practice in one form or another. The discussion which follows outlines some of the advantages and disadvantages of each type of valve for particular applications, their features and limitations, and some of the factors to consider in their selection.

Globe Valves

Globe valves have a particular field of application in the handling of gases and steam. They may be obtained for drip-tight shut-off, are suitable for throttling service, and require little maintenance because of the relatively few moving parts. Straight-through pattern globe valves have a higher head loss than any other type of valve and should not be used except for throttling service. The angle pattern has a relatively low head loss and is even better for throttling than the straight-through pattern. Globe valves may be obtained with either self-grinding metal seats or composition seats. Where they are used for throttling service, metal seats with stainless steel trim are recommended. Globe valves should not be used where the fluid being handled contains sediment or stringy material as such materials may either damage the seats or become caught around the valve stem or disc. For this reason, globe type valves should not be used in lines conveying sewage or sewage sludges.

Slide (Gate) Valves

Slide valves, more commonly referred to in water and sewage practice as gate valves, may be obtained with either solid-wedges or double discs. In the smaller sizes they are probably the most generally accepted type of valve for ordinary stop service. The AWWA gate valve, since it is a standardized product, is readily available and the least expensive type of valve in the smaller sizes. It provides a clear water way with no obstructions to flow and has desirable hydraulic characteristics. But, the gate valve has a number of disadvantages which make this valve unsuitable for some services; the mechanism required for wedging the discs against the seats in double-disc



Courtesy Henry Pratt

Fig. 2 MANUALLY OPERATED Low Pressure Butterfly Valve

valves, together with the sliding of the seating surfaces which in time results in wear, makes this valve unsuitable for frequent operation. Large gate valves require considerable effort to operate as compared to rotary valves and cannot be depended upon to provide tight shut-off against flow. Of all of the types of valves, the gate valve is the least desirable for throttling service.

Solid-wedge gate valves smaller than 8-inches in size are ordinarily used where a gate valve is to be installed in a vertical line or where some throttling is necessary. Double-disc valves should be of the square-bottom or beamed-waterway type whenever installed in a vertical line or for frequent operations; this construction prevents disc seats from rubbing against the body seats except in final closure. When installed on their side double-disc gate valves should always be provided with tracks and scrapers to support the valve disc.

When installed in lines under negative pressures, gate valves should be placed with their stems horizontally to keep the packing wet at all times. If this is not done, air leakage through the packing may result in loss of prime for pumping equipment. Double-disc gate valves should never be installed in an upside down position as the wedges will fall down and prevent wedging of the disc against the seats. Solid wedge gate valves can be installed in any position but should be installed with their stems horizontally whenever the fluid being handled contains sediment. Solid wedge valves will not seat when installed in a vertical position if any material is deposited between the body seats and where this is likely to occur, they should be installed on their sides.

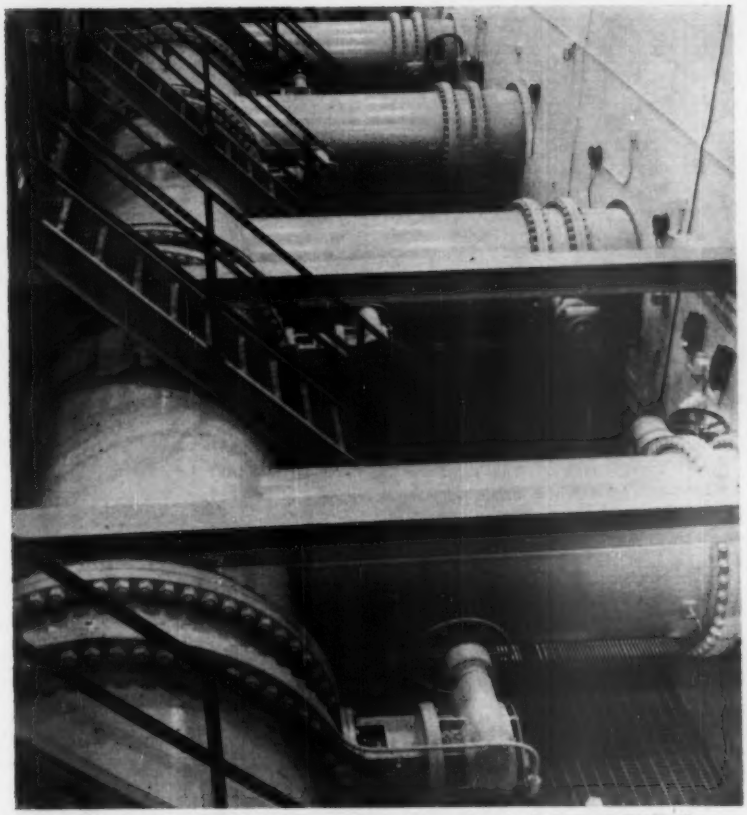


Fig. 3 INSTALLATION OF Large Low Pressure Rubber seat Butterfly Valves

In sizes 16-inches and smaller, the AWWA standard double-disc gate valve has proven itself both in water and sewage works as a reliable shut-off valve. In sizes 24-inches and larger, a number of the large metropolitan cities no longer use gate valves in their distribution systems because sometimes they cannot be operated under emergency conditions. It is now the practice of many large cities to use rotary type valves for all pipelines 24-inches and larger.

Butterfly Valves

The use of butterfly valves in water works practice is relatively new and has only gained general acceptance in the last decade. The most commonly used butterfly valve has rubber seats and may be obtained with the rubber installed either on the valve disc or in the valve body. Most manufacturers at this time are furnishing valves in the latter category. The rubber seat may be relatively narrow and held in the valve body in various ways or may be furnished as a spool which completely lines the inside of the body and extends over the valve flanges. Valves with the rubber seat on the disc or of the spool type in the body, may seat at any angle of less than 90° to the longitudinal axis of the valve; valves with narrow rubber seats in the body usually seat with the disc normal to the longitudinal axis of the valve. Valves with rubber seats may be obtained, at this time, for services up to and including 125 psi although there are indications that in the near future higher pressures may be handled by rubber-seat butterfly valves. For pressures above 125 psi, metal-seat butterfly valves are all that is now available as standard manufactured products.

The general acceptance of rubber-seat butterfly valves by the water works industry has been due to a number of advantages which this valve has over the gate valve commonly used in the past. These advantages include (1) ease of operation, (2) savings in space required for installation, (3) absence of sliding parts and low maintenance, (4) low head loss, (5) driptight shut-off, (6) suitability for throttling service, and (7) reliability of valve operation under normal and emergency conditions. With these advantages, one might question why a valve of any other type would be used, but like all good things, butterfly valves have some disadvantages. Butterfly valves cannot be used for any fluids containing stringy materials which can wrap around the valve disc or stem and prevent closure. Metal-seat butterfly valves cannot be used where drip-tight shut-off is required as it is impossible to obtain complete contact between the disc and the body seats because of imperfect machining and strains from connecting piping.

Any engineer engaged in the practice of specifying butterfly valves should be conversant with the mechanics of calculating the torques required for their operation. The AWWA Standard Specifications for Rubber-Seated Butterfly Valves (AWWA C504) and for Metal-Seated Butterfly Valves (AWWA C505 include tables giving the minimum operator torques required for the various sizes and pressure-velocity classifications of valves. But each of these tables has a note that in many cases, the operator torques can be appreciably reduced for less adverse conditions than assumed by the AWWA specifications. Because the cost of operators for the larger valves is usually an appreciable part of the total valve cost, and can run into thousands of dollars, a considerable savings can be realized sometimes by calculating and specifying torques corresponding to the actual conditions, rather than using the torques given by the AWWA Specifications.

Operator torques can be calculated using the following formulas:

$$T_s = K_s d^3 \quad (1)$$

$$T_b = 0.785 P d^2 r f \quad (2)$$

$$T_d = K_t D^3 V^2 \quad (3)$$

$$V = K_f \sqrt{H} \quad (4)$$

Where:

- T_s = Seating or unseating torque, inch pounds
- T_b = Bearing torque, inch pounds
- T_d = Dynamic torque, inch pounds
- V = Average velocity for gross area of valve, feet per sec
- K_s = Coefficient of seating torque (may be obtained from manufacturers)
- K_t = Coefficient of dynamic torque
- K_f = Coefficient of flow
- d = Diameter of valve, inches
- D = Diameter of valve, feet
- P = Pressure drop across valve, lbs per square inch
- H = Pressure drop across valve, feet
- r = Radius of valve shaft, inches
- f = Bearing friction coefficient, (usually 0.25)

The required operator torque, T_o, is determined from the greater of the two formulas:

$$T_o = (T_b + T_a) \quad (5)$$
$$T_o = (T_d + 1.2\,T_b) \quad (6)$$

Equation (5) is solved using the maximum pressure drop across the valve with the disc in the closed position.

Equation (6) must be solved successively for each one foot integer of velocity to determine the maximum combination of dynamic and bearing torques. The head loss which will occur across the valve for each integer of velocity can be calculated by considering the hydraulics of the entire system. For example, if the maximum velocity with the valve fully open is 16 fps, head losses across the valve corresponding to velocities of 1, 2, 3, ..., 15, and 16 fps should be calculated and tabulated. The coefficient K_f can be determined for each integer of velocity by means of Equation (4) and the corresponding coefficient K_t can be determined by using Figure 4. The dynamic torque T_d and the corresponding bearing torque T_b can then be calculated using Equations (3) and (2) respectively.

Example: Given a 54 inch valve, a maximum velocity through the gross area of 16 fps, a maximum shut-off pressure across the valve of 25 psi, a shaft diameter of 4-7/8 inches, and a system characteristic such that head loss varies as the square of the discharge rate.

Problem: Find the maximum operator torque required:

For the valve in the open position:

$$V = K_f\sqrt{H}$$
$$H = \left(\frac{V}{K_f}\right)^2 = \left(\frac{16}{16}\right)^2 = 1.0 \text{ ft}$$

For the valve in a throttled position, the head across the valve corresponding to any velocity V is:

$$H = 57.8 - \frac{(57.8 - 1.0)V^2}{16^2} =$$

$$57.8 - 0.222V^2$$

For any head H the bearing torque will be:

$$T_b = 0.785Pd^2rf =$$

$$0.785 \times \frac{H}{2.31} \times 54^2 \times \frac{4.875}{2} \times 0.25 = 604H$$

Table 1 is a tabulation of the various factors by integers of one foot velocity:

Figure 5 showing the relation between K_f and K_t was determined from plottings of data from a number of valve manufacturers and from data accumulated by the author while witnessing dynamic torque tests. The curve represents the upper limits of torque values and is applicable to all valves installed in pipelines.

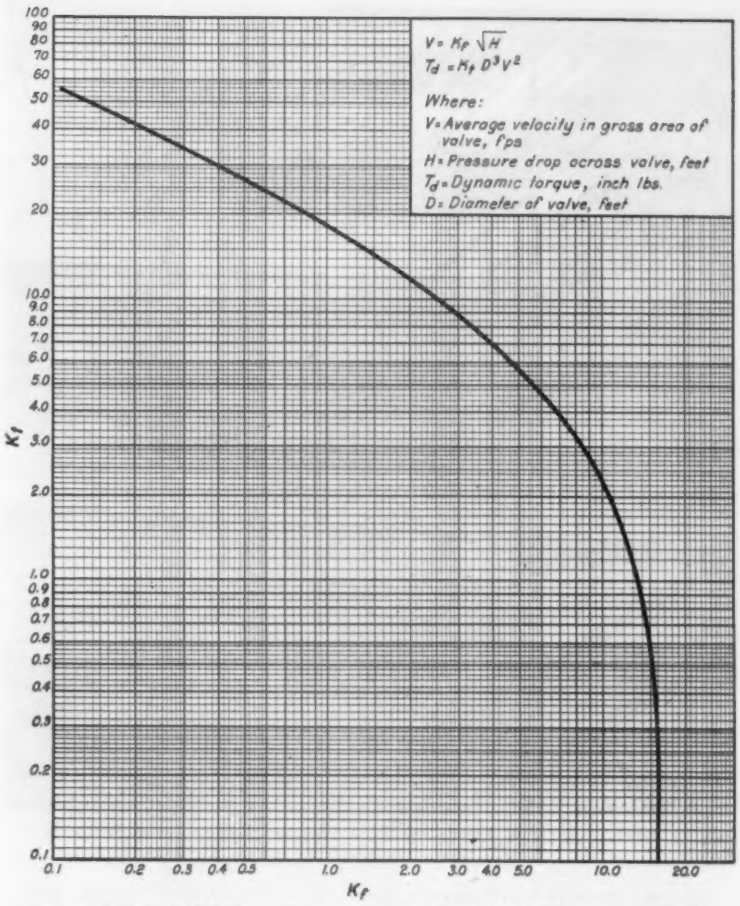


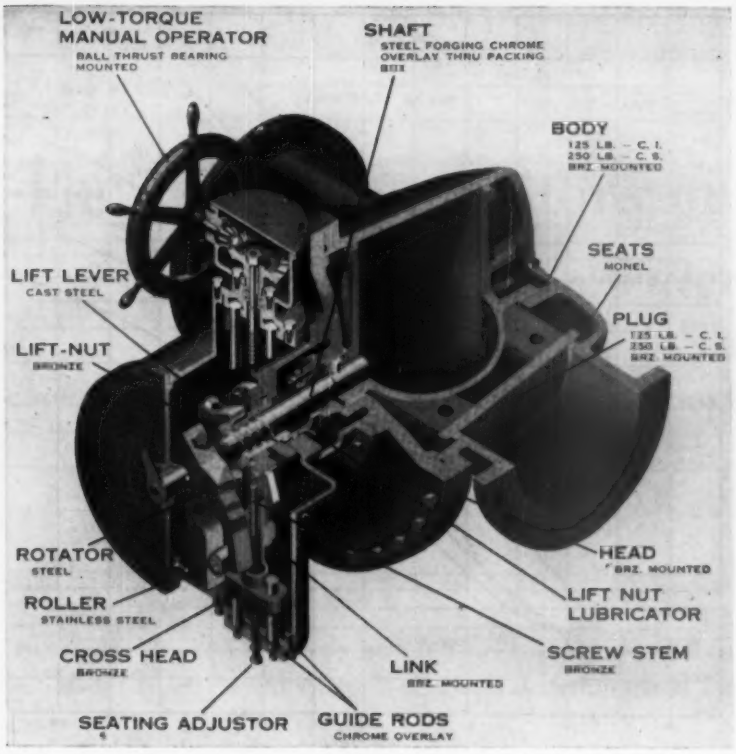
Fig. 4 COEFFICIENT of Torque vs Coefficient of Flow for Butterfly Valves

The above tabulation shows that the maximum combination of (T_d + 1.2 T_b) is 156.2 kip inches. As a comparison, the torque given in the AWWA specifications for a 25-16

Table 1

Results of Calculation of Required Torque

V fps	H ft	Kf	Kt	Td kip in	1.2Tb kip in	Td + 1.2 Tb kip in
16	1.0	16				
15	7.8	5.35	5.3	108.2	5.7	113.9
14	14.3	3.71	7.4	132.0	10.4	142.4
13	20.3	2.89	9.0	139.0	14.7	153.7
12	25.8	2.36	10.5	137.5	18.7	156.2
11	31.0	1.95	12.0	132.0	22.4	154.4
10	35.6	1.68	13.2	120.0	25.8	145.8
9	39.8	1.43	14.5	106.5	28.9	135.4
8	43.6	1.21	16.1	93.5	31.6	125.1
7	46.9	1.02	17.8	79.3	34.0	113.3
6	49.8	0.85	20.0	65.5	36.0	101.5
5	52.2	0.69	22.0	50.0	37.8	87.8
4	54.2	0.53	25.3	36.8	39.2	76.0
3	55.8	0.40	29.0	23.7	40.5	64.2
2	56.9	0.27	36.0	13.2	41.1	54.3
1	57.6	0.13	50.0	4.6	41.7	46.3
0	57.8	0.00		0.0	42.0	42.0



Courtesy S. Morgan Smith Co.

Fig. 5 MANUALLY OPERATED Cone Valve

valve (25 psi shut-off and 16 fps maximum velocity) is 204 kip inches. The list price of a manual operator with a capability of 150.0 kip inches, which is sufficiently close to the calculated maximum torque of 156.2 kip inches to warrent its use, is $1000.00, whereas the list price of a manual operator for the AWWA torque is $2140.00, a difference of $1140.00.

It should be noted that Equation (6) is the algebraic sum of the two values T_d and $1.2T_b$. When closing a valve, T_d is negative and the theoretical operator torque required is the difference between the two values. It is customary, however, to assume T_b as zero under a closing condition since the amount of friction which can be counted upon is indeterminate. If it is assumed in the example above that the maximum velocity occurs only under a line-break condition, then the maximum capability of the operator would be 139.0 kip inches. This value should be checked against the maximum torque required to open the valve under the normal maximum pipe line velocity and shut-off head to determine the maximum operator requirement.

The example above clearly shows that considerable savings can be realized sometimes by calculating and specifying torques to meet actual service conditions.

It has been found from experience that the larger butterfly valves, and this is particularly true for metal-seat valves, should be provided with ribs between the valve flanges to stiffen the bodies against distortion from piping strains. It has also been found that metal-seat valves without provisions for adjustment of the seats after installation are not satisfactory. Valves cannot be installed in pipe header systems without imposing some strain on them. Even very slight strains will distort bodies and seats sufficiently to cause leakage in metal-seat valves. Adjustable seats placed in the edge of the valve discs allow adjustment of seats in the field when excessive leakage occurs. Our firm now follows the practice of requiring adjustable seats for all metal-seat butterfly valves.

Lubricated Plug Valves

Lubricated plug valves may be obtained with either cylindrical or tapered plugs. The cylindrical plugs, in the smaller sizes, may be obtained with full-area round-port openings whereas the tapered plugs are ordinarily furnished with a reduced-area rectangular-port. Plug valves are economical in the smaller sizes and compare in price with gate valves for all sizes through 6-inches. They may be operated frequently without appreciable wear and are relatively easy to operate, but where not operated periodically they sometimes freeze requiring removal from the line for maintenance. For this reason, lubricated plug valves are usually not used as stop valves in water distribution systems or other locations where periodic operation is not assured. Lubricated plug valves with full-area round-ports or full-area rectangular-ports are commonly used in sludge lines for sewage treatment plants. They have proved satisfactory in this service and are generally accepted by the sewage works industry.

Cone Valves

Cone valves are basically a tapered plug valve with the plug being a frustum of a cone with a full-area round-port opening. The basic operation is such that the plug is pulled axially from the seats before it is turned which prevents rubbing of seat surfaces against each other. Cone valves are considered as the most reliable and easiest to operate of all valves availbale to the engineering designer. Thy have relatively no head loss as their port opening conforms to the area and shape of the connecting piping. Since the initial cost of cone valves is higher than any other type, they are used in only those locations where extreme reliability is required. Because the head loss through a cone valve is very low, it is customary to reduce the size to approximately seven-tenths of the size of the connecting piping. Cone valves cannot be expected to provide drip-tight shut-off. However, for most installations, the leakage is negligible.

Spherical (Ball) Valves

Spherical or ball valves are of the rotary type with the plug seats machined to the surface of a sphere. The action of the plug is entirely rotary, with the seats slightly eccentric, so that they wipe into one another as the plug is turned; the seats do not slide against one another but part immediately. Spherical valves have essentially all of the advantages

of the cone valve previously discussed, because all motion is rotary, and sliding of parts against one another is kept to a minimum. It is believed that the spherical valve may be used in practically all of the applications and with the same degree of reliability and advantages as the cone valve. It is questionable whether the cone valve can ever compete with the spherical valve on a price basis since the operating mechanism for the cone valve is basically more complicated. One of the major manufacturers of spherical valves does not recommend their product for frequent operation or when power operated as they contend that the wiping action of the seats, one into the other, results in more wear than for cone valves. The writer's experience with spherical valves is not sufficient to contest this statement, although the writer's firm has installed spherical valves in pump discharge check service which, so far, have proven entirely satisfactory.

Swing Check Valves

The general features of swing check valves are commonly known and will not be described. Swing check valves have been used for years to prevent reversal of flow in pipelines or on the discharge side of pumps. They are satisfactory for small flows or where the discharge line is relatively short. But, there is no such thing as a swing check valve which will prevent water hammer. Starting and stopping pumps always creates pressure surges and the only advantage of some types of swing check valves over others is the facilities to assure seating of the disc before reversal of flow takes place. If the disc in a swing check valve is not seated prior to reversal of flow, any surges created by changing the pipe line flow will be amplified and will create a dangerous condition. For this reason, any swing check valve should be provided with a lever and weight, a spring, or have an inherent characteristic to assure closure of the disc before reversal of flow. Again, it should be emphasized that this type of facility does not eliminate or reduce water hammer caused by changes in pipeline velocity. Where pressure surges will be encountered which are in excess of the work pressure of the pipelines, provision should be made to reduce or relieve the surges to within allowable limits.

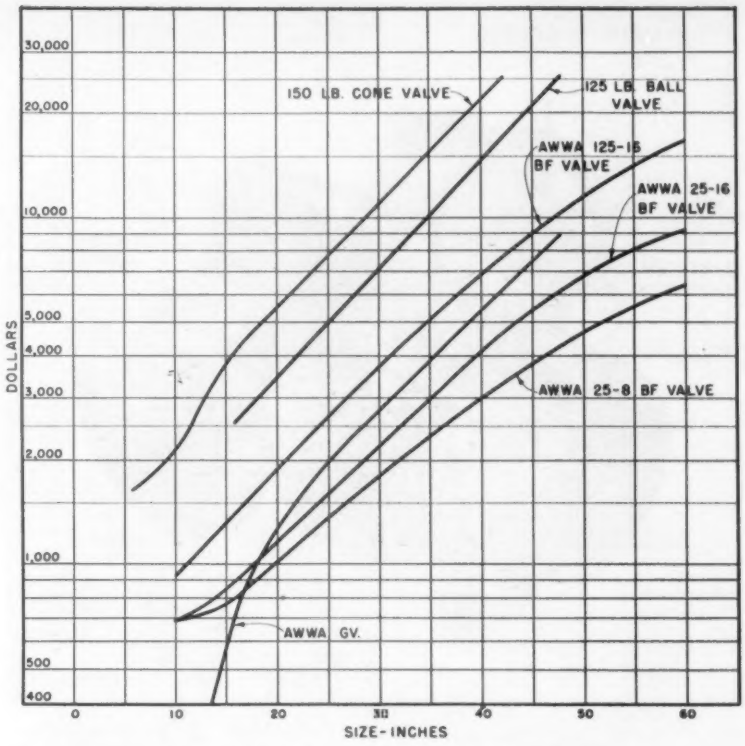


Fig. 6 COMPARATIVE COSTS for Valves with Manual Operator Dec 1958

Relative Initial Costs for Valves

Figure 6 has been prepared to show the relative costs for butterfly valves, gate valves, ball valves, and cone valves. The prices are based on manufacturers' current list prices and are probably at least 10 percent above prices which would be quoted to contractors. Prices are based on valves equipped with manual operators sized to provide operation with a pull on the handwheel of not exceeding 40 pounds. The gate valve prices include an allowance for bevel gears and grease cases for sizes 16-inches and larger and standard AWWA bypasses for sizes 24-inches and larger. The curves show that 25 pound butterfly valves cost less than gate valves in sizes above 18 inches and that all other types of valves cost more than gate valves for all sizes. When comparing ball valves and cone valves with both gate valves and butterfly valves, it should be remembered that both of these types of valves may be used in smaller sizes than butterfly and gate valves with an equivalent head loss. When making comparative cost studies for preliminary estimating and design purposes, prices may be used for ball valves and cone valves having diameters of approximately seven-tenths the diameters for gate valves and butterfly valves.

Summary

Before selecting a valve for a particular operation, it is incumbent upon the engineer to study all of the conditions to make a proper valve selection. In general, it may be stated that standard double-disc gate valves can be used with assurance in sizes less than 18-inches where frequent operation, throttling, or corrosive conditions are not involved. In sizes 18-inches and larger, it is necessary to give careful consideration to many factors in order to assure the selection of a valve which will be adequate for the service. Operator torques should be calculated for large butterfly valves to meet the application conditions for maximum economy.

Acknowledgments

The author wishes to express his appreciation for the cooperation given by a number of valve manufacturers in furnishing cost information and pictures for use in this paper.

The dollars and cents cash outlay required and the amount returned in lower power costs are discussed in—

The Use of Capacitors in *Water & Sewage Plants*

Part II

By E. O. POTTHOFF
Components & Intermediate Distribution Department
General Electric Co.
Schenectady, N. Y.

EDITORS NOTE: This second part of Mr. Potthoff's article describes the mounting and selection of capacitors and discusses a representative installation program.

■ TWO GENERAL types of capacitor connections are used for power factor correction; connection across motor terminals and connection across bus. Fig. 8 shows a typical connection arrangement of capacitor connected to the terminals of a motor. With this arrangement, the capacitor is obviously switched to and from the bus with the motor. The capacitor provides leading reactive current to the bus only while the motor contactor is closed.

Fig. 9 shows a typical type of connection in which the capacitor is connected directly to the motor bus. Similarly, capacitors are connected across power lines to perform the same function. Obviously, the capacitor will deliver leading kva to the bus if the motor contactors are open or closed.

Capacitors are physically mounted in a variety of locations dependent to a great degree on the size of the capacitors and the space available for their mounting. If capacitors are connected across motor terminals, they may be mounted in a steel box next to the motor connection box. When so located and connected, excellent protection is given the motor insulation against damage from steep electrical wave fronts as the capacitor will reduce the rate of voltage rise. When used in conjunction with lightning arrestors, the most complete form of protection is given the motor insulation against damage from overvoltage due to lightning.

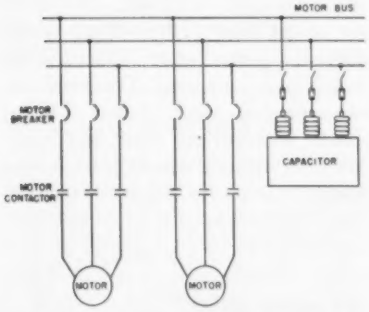


FIGURE 8. TYPICAL ARRANGEMENT of Capacitor Connected Across a Motor Bus

KVA Needed

Some utility rate structures specify a minimum plant power factor that must be met with no credit given for further improvement. In this case, there may be little or no incentive to improve the power factor above the base level.

In other cases, utility rate structures provide a uniform credit incentive to at least unity plant power factor. However, due to the fact that we are dealing with the cosine of an angle approaching zero degrees as additional capacitors are provided, the rate of improvement of power factor

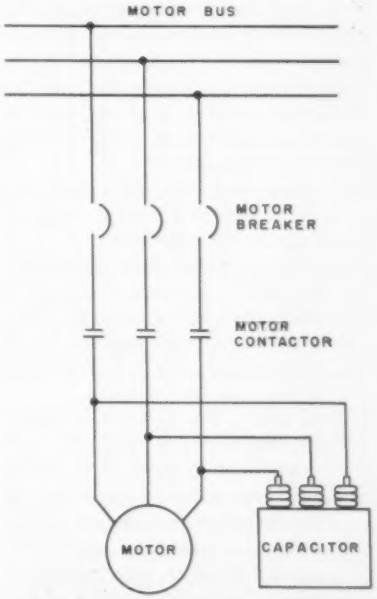


FIGURE 9. CIRCUIT ARRANGEMENT for Connecting Capacitors to individual Motor terminals

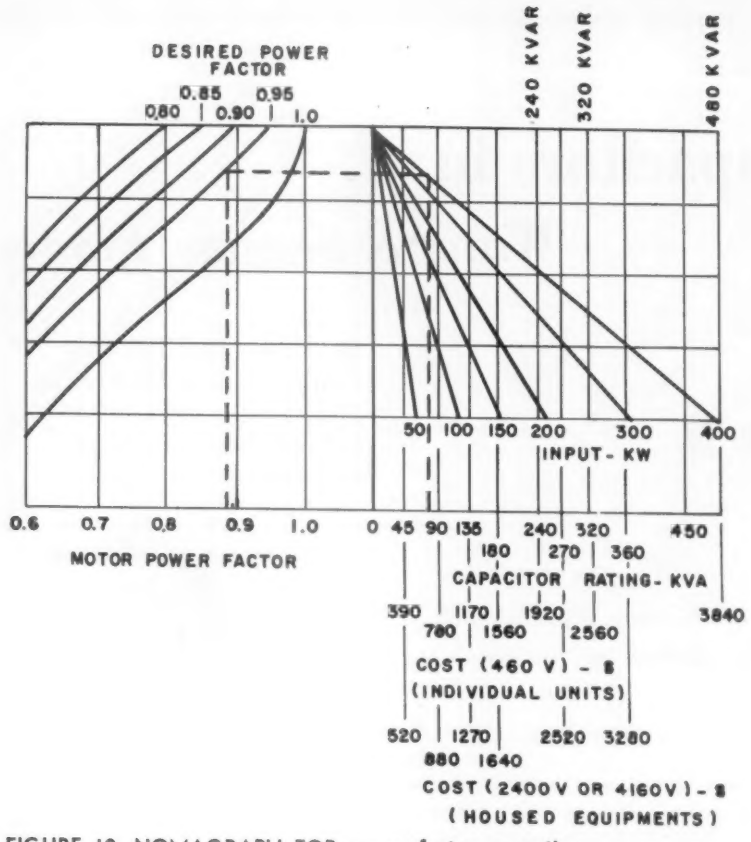


FIGURE 10. NOMAGRAPH FOR power factor correction

decreases as unity power factor is approached. Therefore, study must be given each case to determine how far plant power factor should be improved.

As a practical approach to the problem of deciding if the addition of capacitors is feasible, the following steps are recommended:

1. Obtain the applicable power rate from the electric utility supplying power to the plant.
2. If a minimum plant power factor only is required, do no more than meet this minimum unless system capacity can be freed economically or if low voltage levels can be improved.
3. If there is a general incentive to improve power factor improvement to very high levels, work out cases of power factor improvement to different levels. Compare costs of capacitors against gains in reducing power costs. Select the number of capacitors and improved power factor that will provide the greatest return.

Simplified methods are available to determine how much capacitor kva are required to raise the power factor of a load to an improved level. Fig. 10 illustrates a relation between original motor power factor, a desired operating power factor, motor kilowatt input and finally capacitor ratings and costs. These curves are based on July 1958 prices. The motor kilowatt input can be computed from the formula (horsepower and motor efficiency at full load only):

$$\text{kw input} = \frac{\text{hp} \times 74.6}{\%\ \text{motor efficiency}}$$

The curves can be used as follows:

Assume a squirrel cage induction motor with a horsepower rating of 500 at 900 rpm and a voltage rating of 2,300 at 60 cycle. Assume that the power factor is to be corrected to 95 percent at full load. Motor efficiency is 93.1 percent and the power factor is 89 percent. The kilowatt input is $500 \times 74.6 \div 93.1 = 400$ kw. The broken line in Fig. 10 traces the path through the curves to a solution. Starting at the lower left, at 89 percent original power factor, run a line vertically to intersect the line denoting desired power factor. From this point of intersection, project a line to the right far enough to intersect the 400 kw input line. Bring this point of intersection down to the lower right, where the capacitor rating and equipment cost are read directly. In this example, the nearest rating is 90 kva at a cost of $880. These figures do not cover any switching equipment for the capacitors.

One important point to note is that there is a limitation on the capacitor kilovolt-amperes reactive that can be connected across the terminals of an induction motor. Limiting values should not be exceeded because of the possibility of over-excitation of the motor or damage to its shaft.

This same technique can be used when loads are identified in terms of horsepower. In such a case use the original plant power factor instead of motor power factor. The remainder of factors will be the same as those for motors as covered previously.

Alternate Sources of Leading KVA

Capacitors are not the only types of apparatus that can produce leading kva in a system. Synchronous motors and synchronous condensers have this same ability. Synchronous motors are rated either unity or 0.8 leading power factor. Although the former rating produces no leading kva and the latter only a small amount percentage-wise, the value in using synchronous motors in water plants particularly, cannot be minimized. In these plants, the finished water pumps are usually so large as to be the dominant load in the plant. Therefore, the power factor of the plant is essentially the power factor of the finished water pump motors. The need for capacitors in water plants is found mostly in relatively small and medium sized plants where synchronous motors cannot be justified for finished water pump drives. Synchronous condensers are used in electric utility systems and never in water and sewage plants.

The general picture is different in sewage plants. In only the largest plants can synchronous motors be

justified for driving raw sewage lift pumps. Therefore, capacitors become a logical choice for correcting power factor in most sewage plants.

No short cut is possible in determining whether synchronous motors or induction motors with capacitors should be used in any given installation. Several factors go into the costs of a drive. These include initial cost, efficiency, power factor and expected installation, maintenance and repair costs. The only method that has been used successfully is to investigate both types of drives and select the type best suited for the individual installation. For a complete guide to drive section, see "Motor Drives for Water Pumps", October 1953 *Journal of the AWWA*.

Representative Program

The following problem is analyzed in order to illustrate the data and procedures covered in this article.

Assume that a water utility has a squirrel-cage induction motor driving a pump 5,000 hours a year. The motor is rated 200 hp, 720 rpm, 440 volts, 3 phase, 60 cycles. The electric utility supplying power to the station charges $1.50 per kilowatt per month for demand. The energy charge is:

1.2 cents per kilowatt-hour for the first 50 kwh per kilowatt billing demand.

0.9 cents per kilowatt-hour for the next 100 kwh per kilowatt billing demand.

0.7 cents per kilowatt-hour for all over 150 kwh per kilowatt billing demand.

motor is equal to the horsepower rating times the constant .746 and divided by the motor efficiency. This equals 200 × .746 ÷ .915 = 163KW. The billing demand charge equals the kilowatt demands times the constant .85 and divided by the motor power factor. This equals 163 × .85 ÷ .86 = 161 KW. The billing demand

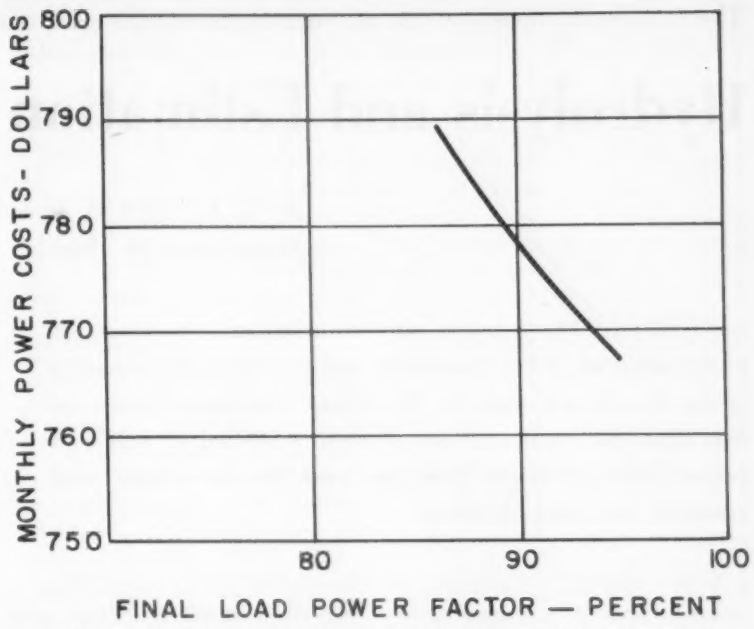


FIGURE 11. CALCULATED MONTHLY POWER bills plotted to show their relationship with motor power factor

charge equals $1.50 times the billing demand or 161 × 1.50 = $242 per month. The billing energy charges are made up as follows:

.012 x 50 x 161 =	$ 96.90
.009 x 100 x 161 =	$145.00
.007 x 43850 =	$306.00
	547.60
Energy charge =	$547.60
Demand charge =	$242.00
Total	$789.60 per month

68000 Total kwhr/month
8050 kwhr billed @ 1.2c
59950
16100 kwhr billed @ 0.9c
43850 kwhr billed @ 0.7c

Repeating this procedure when the motor power factor is corrected to 90% and then to 95%, monthly bills become $778.60 and $766.60 respectively. These values are plotted in Figure 11 to show their relationship with motor power factor as it is corrected to different values.

Using the curves shown in Figure 10, costs of 30 KVA capacitors is approximately $260 and the cost of 60 KVA is approximately $520. The maximum capacitor rating that can be used, if the capacitor is switched with the motor, is 70 KVA, per table, and therefore 60 KVA of capacitors is a safe value. The net savings per month is $789.60 — $766.60 = $23.00 if the power factor is corrected to 95%. Assuming money costs 10% per annum and that equipment is written off in twenty years, the present worth of this saving is 8.51 × 23 × 12 = $2350. The net present worth to the owner is $2350 — $520 = $1830. Similarly, the net present worth to the owner if the drive is corrected to only 90% is $1122 — $260 = $862. Since the maximum return is obtained when the maximum capacitors are used, the customer will find his greatest return when the power factor of the motor is corrected to the maximum of 95%. An immediate expenditure of approximately $520 will lead to a total savings of $1830 over a period of twenty years.

Sewage Disposal in 1741

The modern septic tank settling tank was first built by Richard Cassells of Hesse-Cassel, a former officer in a regiment of German military engineers. As the architect engaged in the building of Tyrone House, Dublin, Ireland, in 1741 Cassells devised an underground tank to receive the house drainage.

Of his plan he writes: "The night soil is to be collected in a tank under the ground builded in lime and stone, of the measurements 8 ft in length by 4 ft wide, by 6 ft in depth, and paved. To this is connected the drain from the soil closet flushed with water and dropped below the water level when the tank is full by a slate trunk, formed of two slabs of slate builded into the wall and closed by a panel of slate between, fixed with copper spuds. This trunk drops the soil into the water under and forms a floating curd on the top which decays and rots and is dissolved to water in time."

Cassells struck the right idea though he was not aware of bacterial action in his method of sewerage disposal.

Submitted by C. J. Robb, Co. Down, Ireland

The continually increased use of synthetic detergents give increased importance to . . .

Hydrolysis and Estimation *of Phosphates*

by R. E. SHOUP, Chemist Division of Laboratories Ohio Department of Health.

EDITOR'S NOTE: A rather extensive study of a narrow range of the literature on the quantitative and qualitative determination of this element was made by Mr. Shoup. This paper reports the data developed on the various procedures studied as well as a method which developed from this work for determining total ortho-poly and meta-phosphate.

■ THIS STUDY was undertaken in an attempt to narrow the range of deviation and reduce the time necessary to determine the total ortho-, pyro-, straight chain poly-, and cyclic-, or meta-phosphate content of public water supplies. This hinged, to a great extent, on devising a rapid system of hydrolyzing pyro-, poly-, and meta-phosphates to the ortho- form.

A review of the available literature suggested no reasonable alternative to the use of the molybdenum blue color complex for the quantitative estimation of phosphorus. There is considerable speculation on the exact properties of the reduced molybdenum compounds. Most of the methods are similar in this respect; they depend upon developing a blue color, in the acid pH range, which is proportional in intensity to the amount of molybdenum that is complexed with phosphorus. Yet, in nearly every range, there are conditions which will produce a molybdenum blue in the absence of phosphorus or any of the other elements, such as tungsten or arsenic, that produce similar reactions.

Techniques and Interferences

Each of the ortho-phosphates exerts its own buffering capacity to influence the pH of the solution. Plateaus were studied at pH's 4.5, 1.8, 0.75, 0.55, and less than 0.5. On each plateau a specific amount of molybdenum reagent and reducing agent would give the best range of standards. The least deviation, thus the best reproducibility, was obtained at pH 0.55 using the concentration of reagents proposed by Denige about 1910.

Some of the erratic results were found to be caused during the administration of the ammonium molybdate and the stannous chloride. A small increment of a highly concentrated reagent is more convenient in a number of applications. Among other things, it minimizes the volume correction factor in quantitative work. However, stratification of concentrated ammonium molybdate, as it is first introduced into a sample, seemed to create conditions that give gross positive or negative errors upon reduction of the system. The same type of deviations would appear upon the addition of the reducing agent. Ideally, the most accurate technique is this area of manipulation is to apply the desired amount of reagent in a quite dilute form while rapidly stirring the sample. Of course, with low phosphate concentrations, this type of procedure dilutes the optional density of the color complex below the range of accuracy.

Working with concentrations from zero to five mg/l of PO_4, most of the procedures provided optical densities that fall within the scope of spectrophotometers using a one centimeter light path. While the wavelength band between 350 and 950 millimicrons was scanned, the procedure which this study determined to be the most acceptable gave maximum discrimination at 670 millimicrons.

For visual comparison with a series of standards, there is a technique in the pH 1.8 range that is quite readable between zero and ten mg/l of PO_4. This first step when hexa-meta-phosphate is present is evaporation to SO_3 fumes and take up with distilled water. This is followed by addition of acid equivalent to 0.1 ml of concentrated H_2SO_4. Under normal conditions this quantity of acid will give a pH in the range from 1.7 to 2.0 when the sample is finally made up to 100 ml. After acidification one drop of 10% ammonium paramolybdate solution, or an equivalent of 5 mg of dry reagent is used. An increment of solution containing about 1 mg of $SnCl_2$ is added before making up to 100 ml.

More techniques were found to approach 100% conversion to the ortho- from hexa-meta-Phosphate than from the pyro-form. Boiling the acidified sample gives somewhat erratic recovery probably due to, among other things, an increase in boiling temperature as evaporation takes place. Recovery was always better if artificial agitation was applied to supplement that caused by boiling.

It is easier to break open the ring of the meta-phosphates to induce hydrolysis than to break apart the chain of the pyro- and poly-phosphates. Sharp changes to low pH, then high pH, and back to the operating plateau was rather successful on meta-phosphates. Recovery of pyro-, however, varied between 30% and 100%. The amount of neutral salt produced as a by product of the pH manipulation invariably caused interference in the subsequent phosphate determination. For example, it was calculated that 2.66 grams of Na_2SO_4 was produced by enough H_2SO_4 to lower the pH of 100 ml. of sample from 1.8 to 0.6, then NaOH to raise the pH back to 1.8. In a sample containing 3 mg/l of PO_4, it produced a blue color with an optical density equivalent to 10 mg/l. Contrarily, the addition of 2.66 grams of reagent grade Na_2SO_4 to 100 ml of the same sample almost en-

tirely retarded color production.

Interference will be introduced by potassium, sodium, and ammonium sulfates and nitrates. Some acceptable results were obtained by lowering the pH with HNO_3 and raising it to above pH 10.0 with NH_4OH, then using HNO_3 again in the regular procedure. This approach was used in much of the original research. Meta-recovery was better than pyro-, using this system. Interference from excess ions should be eliminated by evaporating with HNO_3, then driving off the excess acid before redissolving the residue. Hydrolysis of meta-phosphate was quite consistent at about 90%, while pyro- recovery averaged around 20% by these techniques. It is probable that some phosphoric acid is produced in this manner, and part of it may evolve as the sample reaches dryness.

Reduction Reactions

Each method of analysis eventually returned to the use of $SnCL_2$. Care must be taken to recognize deterioration of the reagent. The amount necessary for uniform reduction of the ammonium phosphomolybdate is rather closely defined. Too much will reduce some of the excessive molybdenum. Also, it seems that an excess of the $SnCL_2$ will allow more rapid oxidation of the tin and produce an intolerable cloudiness from insoluble stannic compounds, probably oxides. While pH and amount of reagents can be varied, they must follow very close ratios. The $SnCL_2$ must be fresh, and, although it is stable much longer, the ammonium molybdate can deteriorate also.

It was finally found that violent boiling for several minutes at about pH 0.55, in the presence of free chlorine or bromine, then dispelling the excess halogen, would give consistant recovery with all three forms of phosphates, singly or combined. The time element may be reduced by the use of bromine as it will be dispelled more rapidly than chlorine. However, aeration by strong agitation, while cooling the sample, will hasten the discharge of the halogen. Sodium thiosulfate does not interfere provided only enough is used to reduce what free chlorine remains after boiling. This should also be the situation with bromine. However, care must be taken to insure that no oxidizing agent is present when the $SnCl_2$ is added.

Table I

Theoretical Conversion Reactions at pH 4.8

$$Na_2HPO_4 + HNO_3^* \rightarrow NaH_2PO_4 + NaNO_3$$
$$Na_3PO_4 + 2HNO_3 \rightarrow NaH_2PO_4 + 2NaNO_3$$
$$(NaPO_3)_6 + 6HOH \rightarrow 6NaH_2PO_4$$
$$Na_4P_2O_7 + 2HNO_3 + 2HOH \rightarrow 2NaH_2PO_4 + 2NaNO_3$$

*HNO_3 may be substituted for H_2SO_4. The quantity of acid used is determined by the pH desired.

Color Development

It is interesting to note the type of colors which developed under various conditions. The normal color in the standards and most of the samples was similar to prussian blue although some samples were a greenish blue. This type developed in the standard into which enough H_2SO_4 was added to lower the pH to 0.6, then NaOH to pH 1.8. The same standard at pH 1.8 with 2.66 grams of reagent grade Na_2SO_4 was a purple blue. When interfering precipitates caused turbidity, the color blend usually leaned toward the green or purple blues. Most of the times, fortunately, the spectrophotometer results at 670 millimicrons were not appreciably influenced by the turbidity.

Quite regularly the color development is on the curve within the few minutes it takes to transfer the samples to the curvettes and make the spectrophotometer readings. At 5 minutes, nearly all readings were too high. At 20 minutes, a non-linear curve was drawn that seemed to break at about 0.35 mg of PO_4 in the sample aliquot. Concentrations greater than 0.35 mg read too low, while those below 0.35 mg read too high. There is somewhat of a tendency to fade in 40 to 60 minutes. The curve at 30 minutes is quite linear, with the deviations at a minimum and evenly distributed above and below the line. About 0.4 mg of PO_4 seems to be the limit beyond which all recovery figures are low. It has been shown that dilution after the color formation gives low results. However, this technique can be used for rough estimation of high PO_4 concentrations since each 50% dilution only causes about 10% to 15% negative error.

Procedure

The following method was developed for hydrolysis and estimation of ortho-, poly-, and meta- phosphates:

REAGENTS: 7-10 H_2SO_4; 70 ml of concentrated H_2SO_4 made up to 100 ml with distilled water.

10% Ammonium Molybdate Solution; 10 grams of reagent grade $(NH_4)_6Mo_7O_{24}{\cdot}4H_2O$ dissolved in distilled water and made up to 100 ml.

2.5% Stannous Chloride Solution; 2.5 grams of reagent grade $SnCl_2{\cdot}2H_2O$ dissolved in 10 ml of concentrated HCl and made up to 100 ml with distilled water.

0.1% Chlorine Water; 2 ml of 5.25% Sodium Hypochlorite solution (household bleach) diluted to 100 ml with distilled water which has been completely oxidized.

0.1% Sodium Thiosulfate Solution; 25 ml of N/40 $Na_2S_2O_3$ solution diluted to 100 ml with distilled water.

PROCEDURE:

1. To 50 ml of sample, or an aliquot containing not over 0.4 mg PO_4, add 2 ml of 7-10 sulfuric acid solution. Mix.
2. Add 1 drop of 0.1% chlorine water. Mix well.
3. Boil with strong agitation for several minutes.
4. Agitate momentarily, after removing from heat, to help dispell the chlorine.
5. Cool to room temperature and add 1 drop of 0.1% sodium thiosulfate solution. Mix well.
6. Add, with swirling or stirring, 1.5 ml of 10% ammonium molybdate solution. Mix well.
7. Add, with swirling or stirring, 1 ml of 2.5% stannous chloride solution. Mix well.
8. Make up to 100 ml with distilled water. Mix well.
9. Read in 30 minutes, against a curve, on a spectrophotometer at 670 millimicrons wavelength.

CHLORINATION GUIDE

This sixth and concluding article of a series on chlorination practices is devoted to tests and equipment for . . .

CHLORINATION CONTROL

by EDMUND J. LAUBUSCH, Sanitary Engineer, The Chlorine Institute, Inc.* New York, N. Y.

AUTHOR'S NOTE: The "Chlorination Guide", concluded by this sixth article of a series, has been provided to review briefly the fundamentals of water and waste treatment chlorination practices; to point out some of the principal hazards and abuses associated with the handling, storage and use of chlorine, and various means by which these can be corrected or minimized; and to delineate, in a practical way, safe and effective operating procedures using equipment evolved from the cautious but rapid advancement of the science and art of chlorination.

By no means is the material that has been presented complete either in scope or detail. It is hoped, however, that the "Guide" will assist in the orientation of newcomers in the sanitary field, and that it also will serve to stimulate renewed concern and interest of operating personnel in the safe, effective and economic execution of their daily tasks. Readers are urged to discuss their chlorine problems and operations with their suppliers and equipment manufacturers regularly and certainly at any time when procedural changes are contemplated. By such means will chlorine continue to serve effectively in pace with increasingly complex requirements of the future.

Introduction

■ FROM THE DISCUSSION in preceding sections of this guide concerned with domestic and waste water chlorination practices and methodology, it is apparent that operating controls are necessary to effect efficient treatment.

This discussion deals primarily with chlorine dosage and residual testing procedures, and highlights some of the mechanics and technics by which chlorination control actually is accomplished.

As in the case of the discussion of chlorine feeders, many types and models of equipment no less useful and vital than those mentioned are commercially available. Space limitations permit mention of only a few equipment items that are gaining popularity in the water and waste treatment field. The reader is referred to the literature and technical brochures of the various equipment manufacturers for a complete discussion of available chlorine feeders and accessory control equipment.

Plant Operating Control

Water. The application of chlorine to water, whether as a gas, in solution, or bound in hypochlorite form, must be controlled within definite limits to ensure satisfactory and economic attainment of the desired ob-

* The Institute and its members make no guarantee of results and assume no liability, jointly or severally, in connection with the information herein contained or the safety suggestions herein made.

**See *Wat. & Sew. Wks.* Part I, Vol 105, p 411; Part II, Vol 105, p 504; Part III Vol 106, p 71; Part IV, Vol 106, p 71; Part V, Vol 106, p 231

Courtesy Hellige, Inc.

FIG. VI-1—COLOR COMPARATOR for Residual Chlorine Tests.

jectives. For example, in chlorine-ammonia applications, dosage control is effected on the basis of chlorine residuals existing completely (or nearly so) as combined available chlorine, while breakpoint and super-chlorination applications depend on the establishment and maintenance of (all or nearly so) free available chlorine. In all applications, pH, temperature, contact time and other influencing factors must be considered.

Through experience with, and an understanding of water chlorination processes, complex applications have evolved, but disinfection continues to be the foremost objective. Demonstration of bacterial destruction currently is the only positive means of establishing the efficacy of treatment. Conventional bacteriological technics are time consuming, however, and results are available only many hours or days after the water has been consumed. Practically, the demonstration of a defined, limiting chlorine residual after a definite period of contact that is established by experimentation and experience, is accepted as the routine basis of control of chlorine disinfection. Actual quality control *by* bacteriological testing, coupled with statistical interpretations, has become a matter of confirmation to satisfy authoritative requirements.

For purpose other than disinfection (see "Chlorination of Water" in *Wat. & Sew. Wks.*, October 1958) marginal chlorine levels suffice in some cases while in others oxidizing levels may be required. However, dosage control usually is on the basis of attainment of defined chlorine residuals which have been demonstrated locally to be of such magnitude and type to achieve the purpose intended.

Because the quality of water source is so variable and also differs from time to time for any single source, effective and economic plant operating control depends on frequent adjustment of chlorine feed to compensate for variations in chlorine demand. To facilitate achievement and maintenance of residuals necessary to effect the desired objectives chlorine demand determinations are employed. The chlorine demand of a water sample represents the difference between the amount of chlorine applied and the amount of free, total or combined available chlorine remaining at the end of a stated contact period. The chlorine dose is that amount of chlorine necessary to effect a specific chlorine residual at the end of a fixed contact period, the combination of which, under well defined operating conditions (pH, temperature, etc.) has been demonstrated to accomplish disinfection or other objectives. Chlorine demand tests for comparative purposes on samples collected from the plant and in the distribution lines also are helpful in determining whether pollution is entering the system. Any sudden increase in chlorine demand (or decrease in chlorine residual) at any regular sampling station warrants immediate investigation.

Standard Methods[1] defines two tests for chlorine demand of water: one for routine plant operation, and a less accurate one for field application. Since there are definite limitations to chlorine demand (and residual) tests, operators should relate chlorine needs directly with results accomplished wherever possible.

Wastes. Operating control of waste chlorination processes presents a somewhat difficult situation. Due to the presence of oxidizable and chlorine-absorbing constituents, chlorine in conventional waste treatment exists almost invariably in combined forms while an appreciable unsatisfied chlorine demand might simultaneously exist. Since sewage chlorination seldom is practiced to the extent that free chlorine forms persist, differentiation of free and combined chlorine is not made.

For the control of sewage disinfection*, a sufficient number of tests must be made to establish the chlorine residual necessary to destroy coliforms or, more generally, to reduce the coliform density to a stipulated amount. The amount of chlorine needed to effect the desired coliform density (as determined by the MPN test or the results of membrane filter tests if acceptable by local authorities) or to meet stream quality criteria depends on the volume of flow and varies with the composition, age and temperature of the waste, the characteristics and presence of inorganic and organic components, the contact time, the condition of the receiving water at the time of discharge and several other factors. As in waterworks practice periodic bacteriological confirmation of the objectives is desirable.

For purposes other than disinfection (see "Chlorination of Waste Waters" in *Wat. & Sew. Wks.*, December 1958) control also can be obtained by routine chlorine residual determinations, always using the same residual testing technics as later described. For some purposes, control is based on a percentage reduction of the total chlorine requirement.

Until recently operating criteria were based largely on determination of the chlorine demand. This is not recognized in the current edition of *Standard Methods*[1] because the term, as defined*, is meaningless in those numerous instances where a higher chlorine residual is required to accomplish the results desired. Now, necessary chlorine dosages are determined on the basis of chlorine requirement. This represents the amount of chlorine (in mg/l) which must be added to sewage to produce a chlorine residual of such strength that, after a definite contact time, the effluent will show a desired coli-

* The term "disinfection" generally refers to a reduction the bacterial population, due to the action of chlorine and does not necessarily imply destruction of essentially all coliforms in a standard sample as is the case in water treatment.

* The amount of chlorine required to produce a residual chlorine content of 0.1 ppm after 15 min contact.

form density, or will meet the requirements of some other treatment objective. Obviously, this operating index affords more flexibility than the chlorine demand, and it embodies, as does the chlorine demand index for water, quality variations and differences in treatment objectives.

Chlorine requirement tests as provided in *Standard Methods*[1] are adaptable to plant or laboratory use and are similar in nature to chlorine demand tests employed in waterworks practice. It should be noted that the value of the chlorine requirement is relative and can not be used for comparing operating results from time to time or from place to place. Its utility lies in its application to the control of sewage disinfection and as an estimate of chlorine needed to satisfy other treatment objectives.

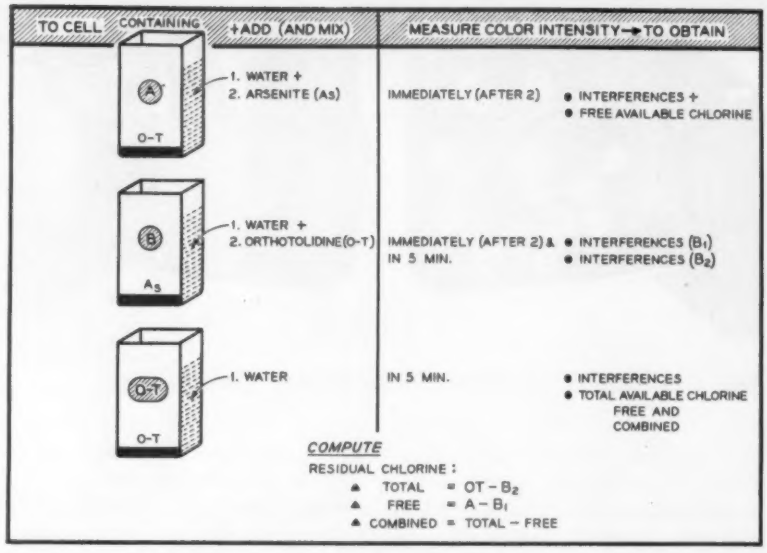


FIG. VI-2—SCHEMATIC of Ortholidinc-Arsenite Test for residual chlorine.

Chlorine Residual Tests

Although tests for chlorine residual serve the same general purpose in water and waste chlorination control, there are some differences in technic between the two. In part, as previously noted, no distinction is made in free and combined available chlorine residual forms in sewage and some industrial wastes treatment practices. The reader is referred to *Standard Methods*[1] for a complete discussion of acceptable test procedures.

Water. Conventional methods for the determination of available chlorine residuals are based on reactions with reducing agents that are not specific for free or combined forms, but specificity can be attained as described below. Basically three tests for residual chlorine currently are accepted for routine chlorination control: colorometric orthotolidine, volumetric starch-iodide (iodometric titration) and amperometric titration. (For highly polluted waters additional test modifications may be required.) None of these differentiate chlorine dioxide from other chlorine compounds.

Orthotolidine (OT) Test. The basic method, utilizing acidified orthotolidine for color reaction, is especially suitable for routine residual control where the total chlorine concentration does not exceed about 10 ppm. The colorometric OT test is rapid and simple, but it is somewhat affected by natural color and turbidity, temperature variations, nitrites, ferric and manganic ions, and possibly by organic iron, lignocellulose, algae and other materials. Because of these inherent limitations and difficulties in compensating for them, some investigators believe that the test has only limited utility in research applications and for continuous automatic recording of chlorine residuals.[2]

Various residual chlorine test kits employing either permanent glass or liquid OT color standards are successfully used at water and wastes treatment plant laboratories. A typical test kit is shown in Fig VI-1. Most units are designed to compensate for the effects of color and turbidity.

The *orthotolidine flash* test modification, performed near 0°C to minimize the effect of chloramines, is used for the determination of free available chlorine. Although oxidized manganese affects the test results, slow-acting interfering substances, nitrites, and oxidized iron do not exert a significant influence.

The *orthotolidine-arsenite* (OTA) test modification measures total, free and combined available chlorine forms in the presence of significant concentrations of interferences (see Fig VI-2). The accuracy of the free available chlorine test fraction is affected by the presence of high concentrations of combined available chlorine, on the sample temperature (which should not exceed 20°C) and on the time interval between addition of the reagents.

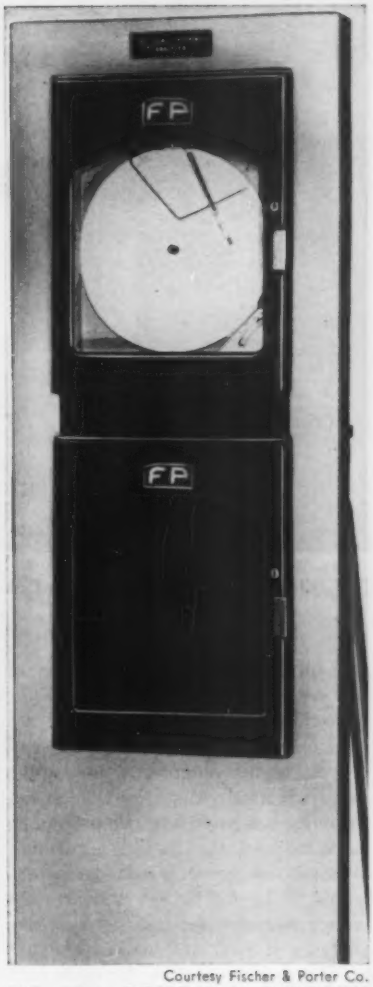
The *orthotolidine drop dilution* test method is applicable for field determination of free residual chlorine where the concentration exceeds about 10 ppm. The test is simple and rapid but it is not very accurate. It is particularly useful in connection with the disinfection of water mains where laboratory apparatus is not available and high order accuracy is of lesser importance.

Iodemetric. This test is based on liberation by chlorine of free iodine from a potassium iodide solution and (acid) titration of iodine using a starch solution to indicate the end point. It is better than the orthotolidine test for determining high total chlorine residuals when the chlorine concentration exceeds 1 ppm; however, when the concentration of total available chlorine is less than 1 ppm the titration end point is difficult to detect. Because of the relative instability of indicator solutions, the large volumes of sample and greater complexity and time required, and because the test currently is satisfactory only for total available chlorine determinations, it is not widely used. Moreover, the interference effects of nitrites and manganic and ferric salts may be considerable.

Amperometric Titration — This test, not suitable for field use, is especially accurate for determining the concentration of total, free or combined available chlorine residuals. It is like the starch-iodine test in prin-

Courtesy Wallace & Tiernan, Inc.

FIG. VI-3—AMPEROMETRIC TITRATOR for Chlorine Residual Determinations.



Courtesy Fischer & Porter Co.

FIG. VI-4—RESIDUAL CHLORINE Analyzer and Recorder

ciple but has a more accurate end point which is determined by observing a meter on a titration instrument (see Fig VI-3). Although it involves a higher degree of skill and care than the previous tests, especially the OT method and modifications, it is unaffected by the substances that are typical interferences with the latter method. The test accuracy, however, is affected by the presence of nitrogen trichloride, chlorine dioxide, free halogens other than chlorine, and copper.

An adaptation of the amperometric technic, having tentative *Standard Methods* status, is available for differentiation of mono- and dichloramines. The adaptation is subject to the usual interfering influences; in addition, it can not be determined in which fraction any organic chloramines that might be present will titrate.

Palin Method—This method, also having tentative *Standard Methods* status, involves serial titration for the determination of free available chlorine, monochloramine and dichloramine, and for the estimation of nitrogen trichloride. As in the case of the amperometric technic, organic chloramines may titrate as either mono- or dichloramines.

Wastes. The same three basic tests are used for chlorine residual determinations of wastes and other highly polluted waters. For combined wastes, the use of one or another may be precluded because of interferences, or special modifications may have to be adopted. In addition, there is approved a rapid spot test (utilizing orthotolidine reagent) for field use and routine plant control.

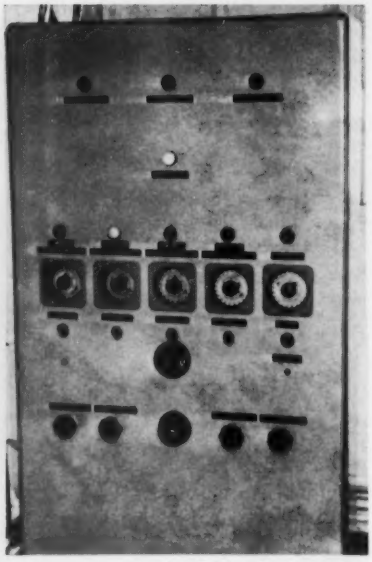
The *amperometric test* is unaffected by color and turbidity—frequently an important consideration in waste treatment control. An unusually high organic content sometimes cause uncertainty in establishing the titration end point but the error is still less than that common to other tests. Provision is made in the test for minimizing interferences due to iron, manganese and nitrites.

The *starch-iodide test* is especially suitable where use of the orthotolidine test is precluded due to the presence of nitrites in excess of 2 ppm and in the presence of substantial amounts of manganic manganese. The precision of the test decreases with increasing concentration of color and organic matter. Residuals so determined generally are in good agreement with those obtained by the amperometric method.

The *orthotolidine test* consistently yields lower chlorine residuals than

Courtesy Builders-Providence, Inc.

FIG. VI-5—MANUAL SETTING of chlorine dosage.



Courtesy Builders-Providence, Inc.

FIG. VI-6—CONTROL PANEL for Remote Chlorination Control.

any other test, probably because of the presence of organic matter. The disparity may be in the range of 2-5 ppm for ordinary settled sewage, and of even higher magnitude for sewage and industrial waste mixtures. A turbidity-compensating comparator is essential and the use of permanent orthotolidine color standards is preferred. The OTA test modification is recommended for industrial wastes analyses if iron and manganese are present and the organic nitrogen content is low.

Automatic Residual Indicators and Recorders

In treatment plants where variations in chlorine demand or chlorine requirement are erratic and fluctuate between wide limits, a continuous indication and record of residual chlorine is an especially desirable operation adjunct. It also is an essential part of automatic chlorination instrumentation. Such equipment facilitates efficient plant operation and control and produces a permanent record of the treatment efficiency. This equipment can be installed in any convenient location at or remote from the sampling cells, and interruptions in chlorine application can be sounded on alarms that can be included as accessories.

Where residual chlorine recording facilities are provided more effective and economical chlorination practices are assured. The system is especially useful in detecting and compensating for sudden or natural changes in chlorine requirements. Moreover, residual recording of the plant effluent furnishes a permanent record of the efficiency of chlorine treatment. Remote location of chlorine residual recorders facilitate efficient and prompt adjustments of chlorine feed from central operating stations and minimizes the necessity of on-the-spot surveillance of treatment facilities.

A variety of commercial units are available. Some units operate on the production of an electric current between two suitable electrodes, and translation of this current (that is proportional to the chlorine concentration) to an indicator and recorder. Depending on the pH value of the sample and the test reagents employed, free or total chlorine residuals can be recorded. Other units involve photoelectric measurement of color intensities produced by orthotolidine or starch-iodide, and automatically compensate for the effects of sample color or turbidity. Most units can be equipped to control chlorine feed to maintain a desired residual (see Fig VI-4).

Chlorine flow rate recorders also offer many advantages. For example, they provide evidence and a permanent record of operation at the chlorinator or at remote sites and provide a constant check on chloride consumed. Moreover, these records also are useful in determining correct chlorine dosages, seasonal and other variations in chlorine demand and in evaluating other valuable operating information. Several commercial units are available and can be tied in with optional alarm equipment at or remote from the recorder site. The recorders also can be located centrally or remote from the point of chlorine application.

Dosage Control Instrumentation

The most elementary form of chlorination control involves manual adjustment of the chlorine feed rate as necessary. The earliest and most simplified form of automatic control provided for automatic maintenance of a fixed dosage rate which reflected variations in flow of the water or waste being treated. Later, additional forms of automation emerged which greatly enhanced the efficiency of chlorine treatment and simplified control by operating personnel. Among some schemes developed are:

Semi-Automatic control—whereby the chlorine feeder is automatically acuated by pumps or timers to deliver a fixed, manually preset chlorine feed rate. In multiple pump installations a step-control regimen can be provided and chlorine feed is automatically synchronized to provide proper dosage for one or a combination of pumps in operation.

Program control — whereby the

chlorine feed rate is automatically varied in accord with a pre-established time schedule. This type of control is utilized more frequently in waste chlorination processes than for water treatment.

Automatic Proportional control—whereby the chlorine feeder automatically and continuously adjusts chlorine feed rate in accord with changes of flow to provide a constant, pre-established dosage at all flows. The desired dosage is manually pre-set by the operator (see Fig VI-5) and, by means of various flow-measuring devices, the chlorine feed rate is automatically controlled to yield the desired dosage.

Most proporietary chlorine feeders can be readily adapted to program, semi-automatic or automatic proportioning control by responding to a vacuum, pneumatic or electrical transmission signal of primary metering elements. The transmitted signal regulates the chlorine feed in direct proportion to the main volume of flow. Moreover, where chlorine feed rate is more advantageously controlled at a point remote from the feeder, most equipment can be so set up to provide for immediate adjustment of the chlorine flow as and when needed (see Fig VI-6). At such installations an indicating chlorine flow transmitter at the feeder location and a flow recorder at the remote station often are provided.

It should be noted that all of the above schemes, by themselves, respond only to changes in flow (quantity) and do not automatically compensate for variations in chlorine demand (quality) of the vehicle being treated. Unfortunately, maintenance of a fixed chlorine dosage often does not provide that a chlorine residual necessary to accomplish the treatment objective will be maintained. Moreover, when chlorine requirements fluctuate due to quality variations of the water or waste being treated, it is difficult to adjust the dosage rate of the feeder to prevent too much or too little chlorine applied.

One of the early instrumentation schemes devised to overcome this shortcoming is based on ORP (oxidation-reduction potential) process control. Briefly, this involves measurement and maintenance of an oxidation potential level (which is a function of chlorine needed) which will ensure the desired results. Currently, while useful in the control of subresidual chlorination processes, control of the amount of chlorine residual by this means is not feasible. The scheme has limited application in domestic water and sewage treatment processes but it has been employed very successfully in the treatment of industrial processes.[2,3]

When the rate of flow to be treated is relatively constant or where fluctuations occur slowly, the chlorinator can be controlled directly from a residual recorder located downstream from the unit. Conventional flow control apparatus is indicated when the flow rate is variable or subject to rapid change. By limiting the rate of change in the control circuit excessive changes in chlorine dosage by the residual recorder can be minimized.[2]

Within recent times yet another approach to fully automatic chlorine feeder control was devised which accounts for changes in both flow and chlorine demand. One unit which is available automatically adjusts the feed rate to compensate for changes in chlorine demand. The unit maintains a constant residual in the water passing through it. The amount of chlorine required to produce this residual is measured and recorded as chlorine demand. This record is then transmitted electrically to the chlorinator which it actuates in proportion to the chlorine demand. In this scheme a signal from the demand recorder, together with a signal from a flow-measuring device, can be fed to the chlorinator which then actuates the chlorinator in accordance with both demand and flow changes.

References

(1) APHA, AWWA, and FSIWA. *Standard Methods for the Examination of Water, Sewage and Industrial Wastes.* New York: APHA, 10th ed. (1955)

(2) Baker, Robert, J. and Griffin, Attmore E. Development of Instrumentation in Chlorination. *J.A.W.W.A.*, 50:4 (April 1958)

(3) Grune, Werner N. and Chueh Chun-Fei. Redox Potentials in Waste Treatment—Laboratory Experiences and Applications. *Sewage and Ind. Wastes,* 30:4 (April 1958)

EDITOR'S NOTE: This is the concluding article of the Chlorination Guide series. Another article by the author on the utilization of hypochlorite chlorine in water and waste treatment processes will be presented in a later issue of this magazine.

Unified Sewer Agency Recommended For Cleveland-Cuyahoga Area

A unified agency to acquire, construct and maintain the sanitary and storm sewer systems would answer the sanitation challenge in the Cleveland-Cuyahoga County area, according to Alfred A. Estrada, of Albright & Friel, at a recent meeting of the ASCE in Cleveland.

A central administrative control of operations for all of the sewage plants would also be part of the program. And, there is no single existing governmental agency which is adequate to meet the problem. Sewage facilities involving several municipalities must be built.

According to Mr. Estrada, the formation of a unified agency would have the following advantages:

1. The water supply of the region, which is primarily represented by the city of Cleveland would be protected from the ever increasing discharge of overflowing cesspools and inadequately treated sewage.

2. The rivers and streams in the area would be preserved for recreational use.

3. The enlarged agency would be in a position to provide treatment facilities.

4. With appropriate powers, it could facilitate and, in some cases, make possible the financing of necessary sewers and sewage treatment works which might be impossible to finance by the individual municipalities.

5. The solving of the drainage problems on a drainage area basis in lieu of a political boundary basis will allow for an orderly development of necessary drainage facilities and the protection of properties along the streams and rivers.

6. The engineering staff of the district would be in a position to make exploration studies and preliminary designs for storm sewers and sanitary sewers in needed areas anticipating necessary improvements.

Observing many kinds of people, over many years, I find the strongest, most competent and reliable man is also the first to admit his inadequacy. . . .

Contradictory as it may sound, he is strong because he is humble.—*J. Edgar Hoover.*

Construction Supervision—Part II . . .

Trench Preparation and Pipe Bedding

AUTHOR'S NOTE: This is the second installment in a continuing series on construction supervision. Written from the viewpoint of the construction man, information in this series is designed to be of practical usefulness to water and sewage works personnel who have responsibility for construction and major repair work.

Initial installments in the series—four or five in number—cover the construction of all types of pipe lines for water and sewage. Part 1, which appeared in the July issue of WATER & SEWAGE WORKS, was devoted to the receiving, inspection and handling of pipe.

by LEO J. RITTER, JR.
Construction Editor

■ A VARIETY of construction procedures are used to open the trench in which a water or sewer pipe is to be laid. Basic methods involve the use of power equipment for excavation, particularly backhoes and trenching machines. In areas of difficult soil or in deep trenches, sheeting and bracing are used.

None of these methods will be covered in detail here. Coverage of this subject is left to a later portion of this series.

As a general rule, the trench should not be opened too far in advance of pipe laying. No more than a few hundred feet should be opened at a time and excavation, pipe laying, and backfilling should follow one another closely. Advantages associated with this procedure include—

1. Reduction of hazards to traffic, passers-by, and workmen.
2. Possible elimination of sheeting and bracing in borderline situations.
3. Possible avoidance of trench flooding, or freezing of the trench bottom and backfill in cold weather.
4. Reduction in cost of supervision, since all operations may be supervised by one man.

Courtesy Clay Products Association

A BACKHOE DIGS a neat trench to the proper depth and width, as a workman measures carefully with a gage stick.

Trench Alignment

The designer establishes the horizontal (and vertical) alignment of the pipe and its trench prior to construction. Location of the trench must be adequately shown on the ground by construction staking, using offset stakes and conventional methods.

Caution must be used on curves to establish a degree of curvature which is consistent with the type of pipe and joint used. In other words, the degree of curvature for certain types of pipe and joints is limited by the ability of the joint to accommodate deflection and still remain intact. Consult the recommendations of the particular manufacturer of the materials being used for specific guidance.

Trench Width

Two basic, and somewhat conflicting, factors are of vital importance in width of trench to be used and in controlling this width during construction. They are—

1. The width of the trench must be sufficient to permit workmen to lay and joint the pipe properly, and to allow proper placing and compaction of the backfill.

2. The trench, at least to a level with the top of the pipe, must be kept as narrow as possible in order to maintain loads on the pipe within those used by the designer.

With deference to the first factor, and in recognition of the vital importance of the second, trench widths must be closely controlled during construction. During design, the type and strength of pipe used are at least partially determined by the loads which will be on the pipe when construction is complete; loads on the pipe from the backfill are in turn a function of the width of the trench. Hence, the designer establishes the trench width as a part of the overall design of the system.

Lack of careful supervision during construction can obviate the value of the most careful design and load to premature and unneccessary pipe failures.

Basic reason for controlling the width of trench in relation to pipe loads is the behavior of the soil in the backfill. The depth of backfill is greater on each side of the pipe than it is over the pipe itself. For this reason, there is apt to be greater settlement on each side of the pipe than directly above it. This downward movement of the backfill actually increases the load on the pipe by pulling down, through friction, on the backfill material over the pipe.

Also, trench walls of undisturbed earth do not settle or compact. Through friction they have a tendency to support the backfill and lessen its settlement. When the distances between the walls of the trench and the pipe are held to a minimum, friction lessens the load on the pipe from the backfill. Conversely, a wider trench results in an increased load on the pipe.

Relative effects of trench width on the load on a pipe from the backfill are shown in figure 1, which is taken from Johns-Manville's *Installation Guide* for Transite Ring-Tite Pressure Pipe. Note the importance of holding the width of trench to a minimum to a level at least to the top of the pipe, or above.

Pipe manufacturers and some codes stipulate the width of trench to be used for each size of pipe. Such recommendations should be carefully followed in the field, in order to avoid overloading of the pipe.

Bell Holes

Where belled pipe is used, and the pipe is to have uniform bearing on the undisturbed trench bottom, bell holes are excavated in advance of pipe laying. They are usually dug by hand methods and should be held to a minimum size consistent with proper installation. Extra space required for thrust blocks, fittings, and so on is handled in the same way.

Depth and Grade of Trench

Grade of the pipe is, of coure, established by the designer and must be closely adhered to during construction. To control grades accurately, many organizations use a system of batter boards and grade string, as illustrated in Figure 2 for clay pipe. This procedure is generally applicable to all types of pipe.

Depending upon the type of pipe, joints used, material in the bottom of the trench, bedding used, and other factors the grade of the bottom of the ditch may or may not be the same as that of the bottom of the pipe. Frequently, excavation is carried to a depth a few inches below the grade of the bottom of the pipe.

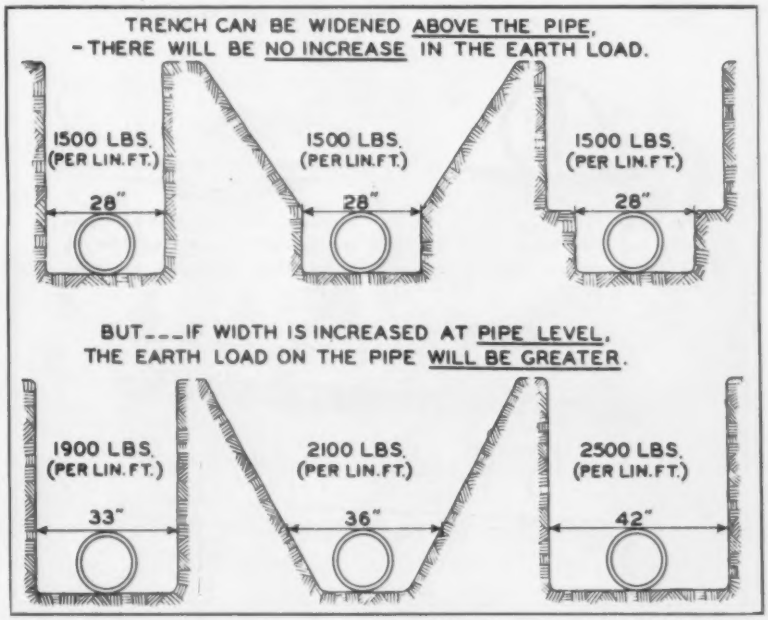
Inspectors should keep a continual check on pipe grades. Where the grade is inadvertently dug too low, approved material should be used for backfill and thoroughly compacted.

Courtesy Clay Products Association

PIPE should be laid in a dry trench. Where water is a problem, appropriate dewatering equipment must be utilized.

Ground Water

It is fundamental that water and sewer lines should be laid in an essentially dry trench.


TRENCH CAN BE WIDENED ABOVE THE PIPE,
- THERE WILL BE NO INCREASE IN THE EARTH LOAD.
1500 LBS. (PER LIN. FT.)
28"
1500 LBS. (PER LIN. FT.)
28"
1500 LBS. (PER LIN. FT.)
28"
BUT---IF WIDTH IS INCREASED AT PIPE LEVEL,
THE EARTH LOAD ON THE PIPE WILL BE GREATER.
1900 LBS. (PER LIN. FT.)
33"
2100 LBS. (PER LIN. FT.)
36"
2500 LBS. (PER LIN. FT.)
42"

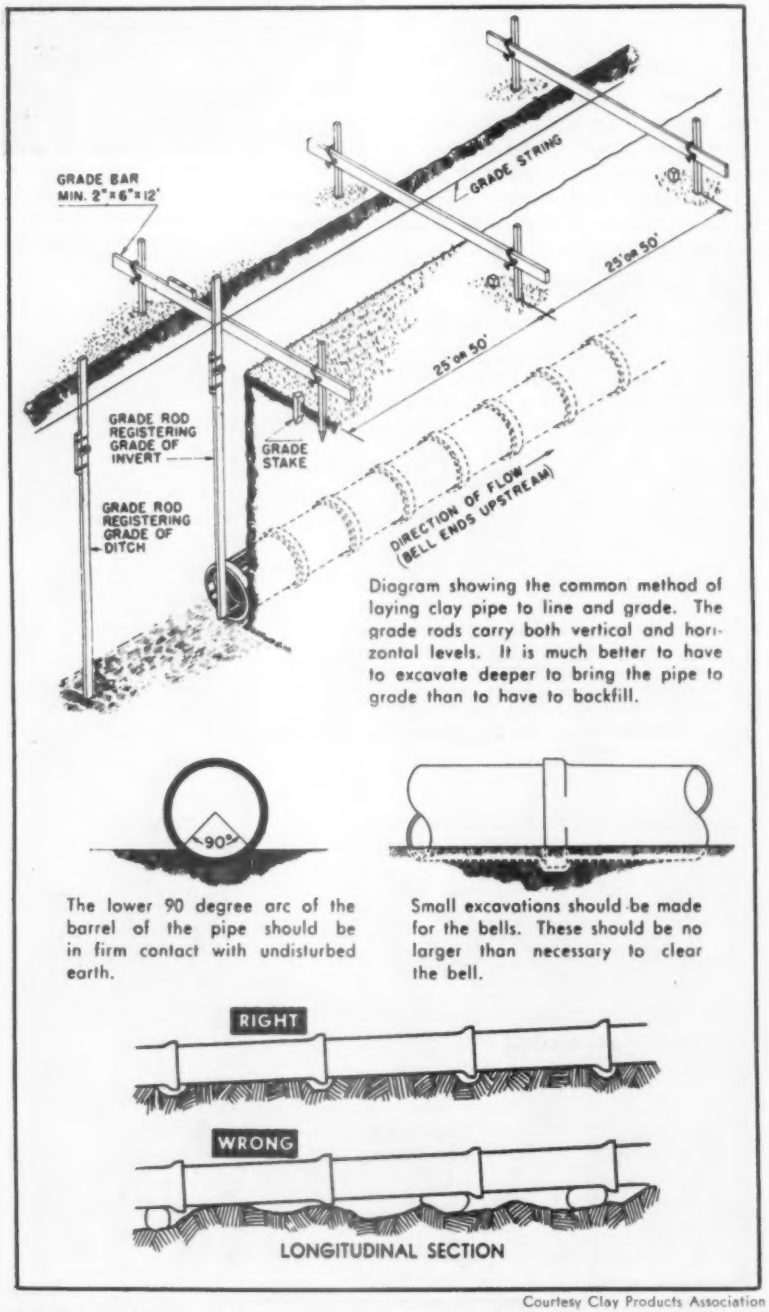
Courtesy Johns-Manville

FIGURE 1. Effect of trench width on loads on pipe from backfill.

In the majority of cases, water may be removed by directing it to small sumps excavated at convenient locations and the use of contractor dewatering pumps. Even fairly large quantities of water can be removed from the excavation in this manner.

Under more difficult conditions—with larger pipe, deeper trenches, excavation below the water table or very heavy ground water flow—a wellpoint system may be necessary. Wellpoint systems are usually installed and maintained by specialized contracting organizations.

FIGURE 3. One method of obtaining uniform bedding of asbestos-cement pipe. (Courtesy Johns-Manville).


GRADE BAR
MIN. 2"×6"×12'
GRADE STRING
25' OR 50'
25' OR 50'
GRADE ROD REGISTERING GRADE OF INVERT
GRADE STAKE
GRADE ROD REGISTERING GRADE OF DITCH
DIRECTION OF FLOW (BELL ENDS UPSTREAM)
Diagram showing the common method of laying clay pipe to line and grade. The grade rods carry both vertical and horizontal levels. It is much better to have to excavate deeper to bring the pipe to grade than to have to backfill.
90°
The lower 90 degree arc of the barrel of the pipe should be in firm contact with undisturbed earth.
Small excavations should be made for the bells. These should be no larger than necessary to clear the bell.
RIGHT
WRONG
LONGITUDINAL SECTION

Courtesy Clay Products Association

FIGURE 2. System of batter boards and grade string used to establish and control pipe grades during construction.

Pipe Bedding

Preparation of the trench bottom and proper bedding of the pipe are additional factors of importance to long life and minimum maintenance costs. Again, carelessness during construction can invalidate the best design and good materials.

Favorable Conditions

In favorable conditions—principally the existence of good firm soil in the bottom of the trench, and pipe which is not too large—usual objective is to excavate the bottom of trench to the required grade and insure uniform support for the pipe along its entire length.

Advantages gained from additional support of the pipe may justify more elaborate bedding arrangements, even in good soils.

Specific bedding practices will vary with type and size of pipe, and many other factors. Manufacturers' recommendations and code requirements should be followed carefully in a particular case.

Pipe on which bells or couplings are used is installed by carefully excavating the trench to uniform grade—finish grading is usually done by hand methods—and the excavation of comparatively small bell or coupling holes. Figure 3, which is taken from Johns Manville's installation guide, illustrates one procedure for uniform bedding of cement-asbestos pipe. Proper bedding of clay pipe is shown in the lower portion of figure 2. This procedure involves shaping the bottom of the trench to fit the shape of the pipe; in figure 2, the lower quadrant of the pipe is fully supported in this manner. A similar effect can be obtained by excavating the bottom of the trench to grade and then backfilling and compacting suitable granular material under the haunches of the pipe.

Pipes which are less rigid in character may require less elaborate preparations of the trench bottom; however, it is axiomatic that the better the support given to the pipe, the greater will be its capacity to support load.

Earth mounds can be used to support certain types of pipe if the trench bottom is firm and if mounds can be constructed that will prevent the pipe from settling. Such mounds extend across the entire width of the trench and must be thoroughly com-

pacted. Follow the recommendations of the manufacturer in locating the mounds along the length of each section of pipe.

Excavation Below Grade

In order to improve bedding conditions—either because of unfavorable soils or in order to increase load carrying capacity—the trench may be excavated below the grade of the bottom of the pipe and backfilled with suitable granular material. This type of bedding is illustrated in figure 4.

Suitable granular materials include sand, gravel, crushed rock, crushed stone and locally available aggregates. Common practice calls for the layer of granular material to have a compacted thickness of at least 3 inches (sometimes 4 inches). Maximum thickness may range from 6 inches to 2 feet or more, depending on soil conditions.

Careful and adequate compaction of the granular material is essential for uniform bedding. The material should be placed in layers (some specifications say uncompacted thickness of 3 inches per layer), the moisture content controlled, and good compaction achieved. Small powered tampers and compactors are ideal for this purpose.

Rock Trenches

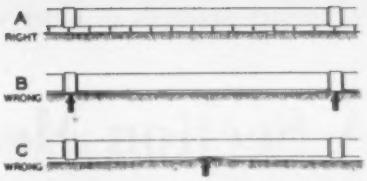
Direct contact with rock or other hard, unyielding material is a high potential source of drainage to most types of pipe, because of high localized stresses which are thus created and possible resultant damage.

If the trench bottom is rock or some other hard material (such as hardpan) or a stony soil, the usual procedure is to excavate below the grade of the bottom of the trench and backfill and compacted granular material to act as a cushion. Depth of the granular layer may be governed by the size of the pipe, but usually is a minimum of 4 to 6 inches and a maximum of 12 inches or so.

Weak Soils and Improved Beddings

In very weak soils, or in order to increase load capacity, more elaborate pipe beddings may be used. A common procedure in such cases with certain types of pipe is to encase the lower portion of the pipe in a concrete cradle. Concrete of low strength is used.

The depth to which the pipe should be embedded in the concrete is a function of the diameter, particularly for the larger sizes. General requirements are that the minimum thickness of concrete be equal to ¼ (or ⅓) the diameter of the pipe, but no less than 4 inches. Twelve-inch depth of concrete is often regarded as a maximum for the larger sizes. The concrete is poured and the pipe bedded in it before the concrete has set.



Courtesy Johns-Manville

FIGURE 4. Bedding conditions in which a layer of granular material is used to support the pipe.

In unusual circumstances, the pipe may be completely encased in concrete, structurally designed to withstand the loads placed upon it.

In extremely weak soils, such as in swamp locations, special treatments are necessary. The bottom of the trench can conceivably be stabilized with a thick layer of granular material. Alternate solutions consist of construction of foundation supports for a cradle for the pipe. For example, the supporting structure may founded upon piles. Design and construction both receive special attention in such cases.

Unusual Conditions

Installation of pipe lines under unusual circumstances is beyond the scope of this series. In these cases, each installation must be treated as a special case; both design and construction may be difficult. As before, careful attention to construction supervision is necessary to insure that the pipe will fulfill its intended function over a period of time.

Included as unusual conditions and not covered here are such items as conduit construction in embankments, trestle supports for elevated crossings, and submarine installations.

Courtesy Steel Plate Fabricators Association

A SECTION OF STEEL water pipe is lowered into a prepared trench.

Aluminum determination in water, forestry practices in water works, and the biologists role in water studies stimulate the

Penna. AWWA Section Meeting

A Meeting Report by
Fred C. Maurer, Managing Ed.

EDITOR'S NOTE: The eleventh annual meeting of the Pennsylvania Section, AWWA was held at Galen Hall, Wernersville, Pa. Highlighted here are some of the papers presented at this meeting.

FORESTERY IN WATER OPERATIONS by James F. Heagy, American Water Works Service Company, Inc.

One point that is often overlooked by waterworks people is that the quality of conservation, and/or watershed bear a direct relationship with the cost of water at the faucet.

Since the amount of trees or vegetation definitely affects the amount of water available to the hydrological cycle, the amount of water available can be improved by intelligent cutting of vegetation and trees. This cutting or pruning, should not be allowed to denude an area so as to cause flash floods, but deep enough to protect the forest floor cover, and at the same time eliminate some of the transpiration.

A properly maintained forest floor will provide more water than that normally available from bare ground to the higher evaporation rate from bare ground. However, it must be remembered that the deeper the litter cover on the forest floor, the higher the interception rate, and the higher the interception rate the less water will percolate into the ground or pass on to streams and lakes. This makes less water available for use.

Planned Planting is one of the best presently known methods of making more water available. Planned planting makes possible the control of transpiration by the use of special plants, and makes it possible to do less cutting and thinning of vegetation in order to lower the transpiration rate. Sprout cutting is also an important factor in maintaining the gains made in water yield made possible by planned planting and cutting.

Recommended reading for waterworks personnel is the U. S. Forestry Commission Study on Better Watershed Management.

THE ROLE OF THE BIOLOGIST IN WATER STUDIES AND TREATMENT by Charles B. Wurtz, Dolan and Wurtz, Consulting Biologists.

The application of Bio-assays to the water field was primarily developed as a result of the clean streams program.

Any biological study made must have a reason and must result in a cure, or recommendation that, if followed, would result in a cure.

Citing one case in particular, dealing with the Wissahickson Creek, near Philadelphia, it was pointed out that the creek was one of the main industrial locations, and all the industries that were discharging wastes into the creek had excellent waste treatment plants and were discharging better quality water into the creek than that which was taken out for use.

After the bio-assay, it was determined that the contamination of the stream was the result of the bleeding from poor, inefficient home septic tank systems.

DETERMINATION OF ALUMINUM IN WATER by Kenneth E. Shull, Vice President, Philadelphia Suburban Water Company.

Mr. Shull reported in his paper the principles of a new procedure for the determination of small amounts of aluminum in water. The new procedure is the result of many tests and research done in many laboratories throughout the country.

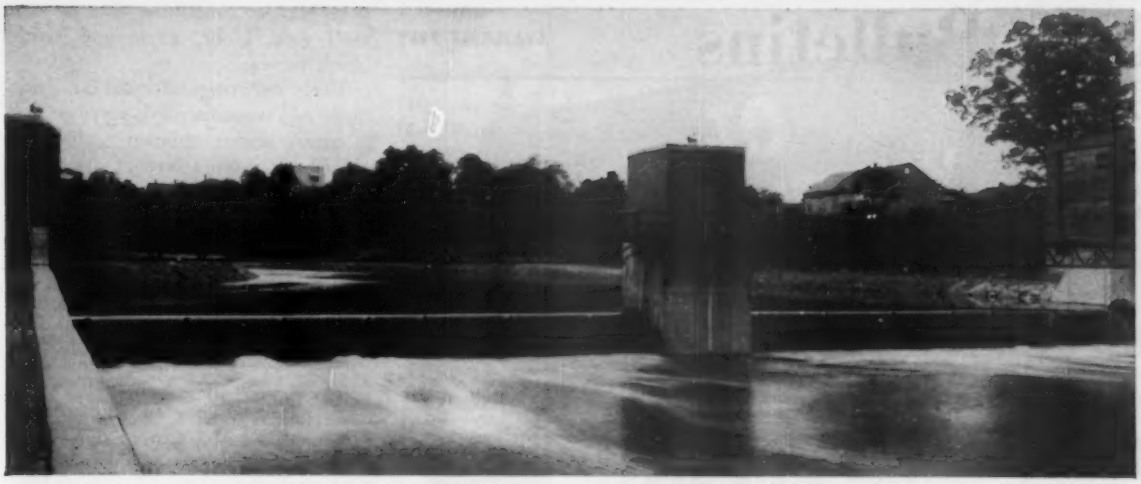
The new procedure is based on the fact that dilute aluminum solutions, buffered to a pH of about 4.0, produce with the ammonium salt of aurin tricarboxylic acid ("Aluminon") a red to pink lake which exhibits maximum absorption near 525 mu.

The intensity of the developed color is affected by the amonut of aluminum concentration, the time allowed for reaction, temperature, pH, the quality of the "Aluminon" used, and the concentrations of the various accompanying ions in the sample.

The interference of iron, chromium and normal phosphate, titanium and other ions is eliminated by the use of thioglycoloc acid. The presence of gum arabic stabilizes the colloidal color system, and by adding citric acid to a sample blank containing color or turbility prevents the aluminum in the sample from reacting with the "Aluminon."

The optimum aluminum range falls between 0.02 and 1.0 mg/litter, but can be extended upward by diluting the sample. The photometric calibration curve follows Beer's Law up to an aluminum concentration of about 1.0 mg/L. It was also pointed out that the minimum aluminum concentration detectable by this method is 0.001 mg in a 50 ml. sample, this corresponds to 0.02 mg/L.

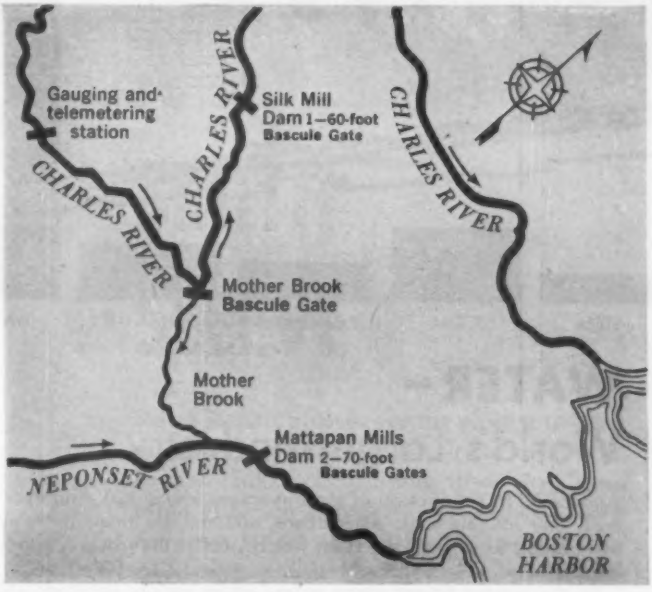
The apparatus needed for this determination is: A spectrophotometer for use at 525 mu and utilizing a light path of 1 cm or longer, or a filter photometer providing a light path of 1 cm or longer and equipped with a green filter showing maximum transmittance between 520 and 540 mu. or; a set of matched, tall form Nessler tubes.



Two 70-foot by 5.3-foot **Bascule** Gates on the dam at Mattapan Mills operate in echelon. As the river rises, one gate moves down until its full capacity will no longer hold the river level; then the second lowers.

ALLIS-CHALMERS BASCULE GATES

Provide Flood Control and Recreation Facilities on the Charles and Neponset Rivers



Four Allis-Chalmers *Bascule* Gates, installed on the Charles and Neponset Rivers just outside of Boston, provide a unique example of the features of this crest control gate. At Mother Brook, a 30-foot by 3.2-foot gate regulates flow in accordance with a court decree requiring that one third of the flow in the Charles River shall be diverted into the Neponset.

A gauging station, five miles upstream on the Charles, measures flow and telemeters it to a proportioning control unit at Mother Brook. A specially-designed A-C mechanism then adjusts the *Bascule* Gate to divert one third of the flow into the brook.

Bascule Gates at Silk Mill Dam and Mattapan Mills, all longer and higher, maintain pool levels for industrial use and recreational purposes. They also limit flood crests during periods of high flow. For complete information on our standard *Bascule* Gate designs covering a wide range of sizing, contact your A-C office, or write Allis-Chalmers Hydraulic Division, York, Pa.

Bascule and *Rotovalve* are Allis-Chalmers trademarks.

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ROTOVALVE • Ball Valves • Butterfly Valves • Free-Discharge Valves

AC ALLIS-CHALMERS

1109

New Bulletins

AVAILABLE FREE

Gratings

811

Blaw-Knox Co., Pittsburgh, Pa., has available a booklet that discusses the safety, visibility, permanence, and easy maintenance advantages of open flooring for industrial and public works applications.

The 24-page booklet features grating applications in sidewalks, locks and dams, and sewage treatment plants.

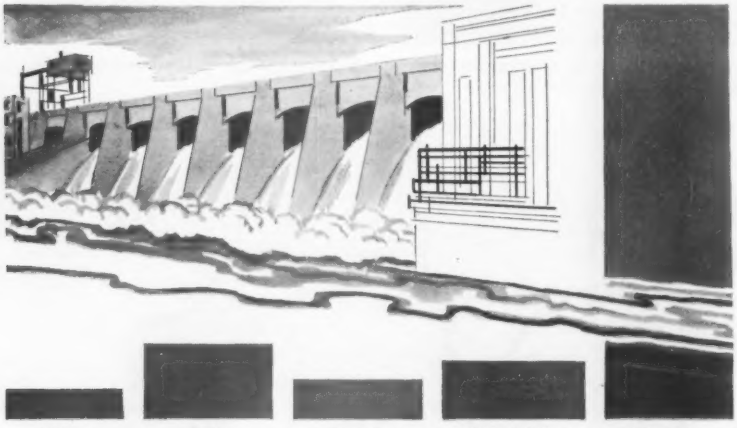
Information includes types and spacing, bearing bar surfaces and weights, fastening methods and safe loads for electroforged carbon steel and aluminum interlock grating. Stair treads are also described and illustrated in the bulletin.

Cast Steel Valves

812

Krotest Manufacturing Company, Pittsburgh, Pa. has available a 20-page booklet containing data on cast steel gate, globe, angle and swing check valves.

Parts ordering information, trim, material, recommended services and a handy figure number index designed for rapid reference are a few of the catalog features which will facilitate ordering of valves.



WATER—
World's Largest Industry

Annual U. S. production of steel averages about 120 million tons; coal, 600 million tons; agriculture, 400 million tons; petroleum, 340 million tons. But, based on weight, water supply is the largest industry.

In the United States alone public water supply averages about 70 million tons per day or 25 billion tons per year. Over 17,000 public water systems in the U. S. supply about 17 billion gallons daily to 111 million people. The average costs is about 10 cents per ton delivered in the home—a little over 2 cents per person per day. To do this requires an investment in plant and equipment of some 7 billion dollars.

The people of the United States now are the largest per capita consumers of public water supplies in all history.

The men who design, build, maintain and operate America's public water works deserve more credit than they receive for doing well a job which is vital to the public welfare and the national economy.

This Series is an attempt to put into words some appreciation of the water works men of the United States.

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

SUBSIDIARY OF WALWORTH

Gear and Fluid Drives

813

Link-Belt Co., Chicago, Ill. has just compiled a 48-page book that presents information on one of the most extensive line of standardized Gearmotors, Motogears and Fluid Drives available to industry. The book "Gearmotors, Motogears and Fluid Drives" describes the functions of these various types of drives and provides detailed selection data, dimensions, overhung load ratings and mountings. It also lists such accessories as couplings, backstops and slide rails.

According to the book, a total of 45 new units has been added to the line and Link-Belt Motogears and Gearmotors are now available in quadruple as well as double and triple reduction units, permitting ratios from 6.2:1 through 985:1. Larger sizes have also been added and capacities now range up to 100 hp. with output speeds from 280 r.p.m. down to 1.8 r.p.m.

Pneumatic Transmitter

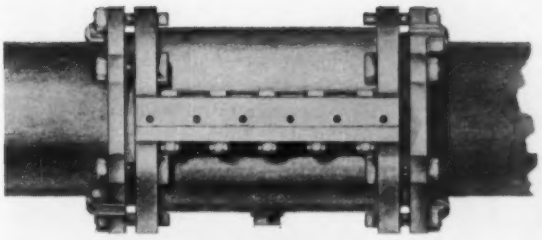
814

B-I-F Industries, Inc., Providence, R. I., has published a new bulletin describing the Builders-Providence BalanCel, a pneumatic transmitter which produces a change in output pressure proportional to a change in differential loading pressure within one-half of one percent of full scale range. The Model AT-SD BalanCel Pneumatic Transmitter is specifically designed for the water, sewage and industrial fields for accurately transmitting rate of flow, loss of head, liquid level measurements, etc. over distances to operate meters, valves, controls, etc.

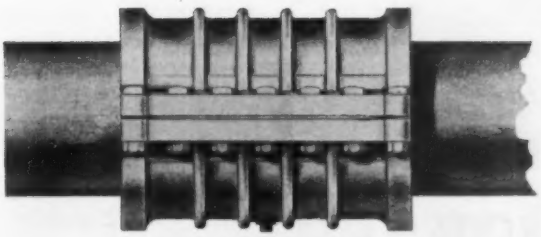
The four page bulletin contains a photograph of the 4 lb. transmitter, schematic diagram of internal parts, three typical installation diagrams, explanatory text, dimensions and specifications.

CONTINUED ON PAGE 102A

INSTALL A SMITH SLEEVE



Mechanical Joint Repair Sleeve



Bell (Hub) End Repair Sleeve

Smith Repair Sleeves are the answer to permanently repairing and quickly returning broken and cracked piping to service. Two types of Smith Repair Sleeves are available for installation on standard classes of cast iron pipe. Smith Mechanical Joint Repair Sleeves are produced in sizes 4″ thru 12″; Smith Bell (Hub) End in sizes 4″ thru 48″. Unskilled labor can speedily install Smith Mechanical Joint Repair Sleeves even in wet excavations. Bell End Repair Sleeves are most frequently installed with caulked lead joints. Smith Repair Sleeves reinforce the broken — cracked pipe and their service life equals the life of the pipe.

62

FIRE HYDRANTS · VALVES · SINCE 1898

THE A.P. SMITH MFG. CO.

EAST ORANGE, NEW JERSEY

New Bulletins

CONTINUED FROM PAGE 128A

All Plastic Vacuum Filter

815

B-I-F Industries, Inc., Providence, R. I., has released a new bulletin describing the new, all plastic Proportioneers Vacuum Filter of cylindrical construction for more efficient and more economical swimming pool filtration. The Proportioneers Vacuum Filter, using filter aid as the filtering medium, is made in seven sizes, from 45 square feet up to 465 square feet. It is designed for municipal, institutional and commercial swimming pools, ranging from 45,000 gallons.

According to the bulletin, features of the filter are low original cost, low operating cost, less horsepower recirculating pump, longer runs between washings. Open tank construction gives complete visibility and lends itself to easy hosing down or chemical cleaning.

The two color, two page bulletin features descriptive text, cutaway drawings of the filter identifying parts and a typical piping installation.

FREE
Complete Ford catalog No. 50 of time and money saving meter equipment.

FORD SPECIAL
METER TESTING BENCHES
offer High Efficiency

In many large meter shops the volume of testing justifies special equipment. The possibilities are worth investigating. Write for information.

THE FORD METER BOX COMPANY, INC.
Wabash, Indiana
FOR BETTER WATER SERVICES
FORD

Small Sewage Treatment Plant

816

Walker Process Equipment, Inc., Aurora, Ill. has released a bulletin describing an entirely new small sewage treatment plant called Sparjair. According to the bulletin, these package type plants, range in size from as low as 50 pop. equiv. to 5000 and utilize the contact stabilization process to produce a clear, nuisance free effluent. The plants feature simple, odor free operation, requiring only part time daily attention; and need not be isolate.

Automated Water System

817

Femco, Inc., Irwin, Pa., has released a bulletin explaining a new simple and reliable monitoring, telemetering and remote control system for the water supply field.

According to the bulletin, the Femco "CMC" System provides telemetering for water levels, and monitoring and remote control for pumps and valves from a central control station. All indication and control functions can be performed by utilizing only a single pair of wires. Existing telephone lines can also be used.

Tank Maintenance

818

Dixie Tank & Bridge Co., Memphis, Tenn., has available the latest copy of the company's quarterly booklet "Tank Talk."

The booklet gives details on tank maintenance, information on costs of tank reconditioning, the use of a mechanical sander, and 2 pages of typical questions and answers about tank maintenance and reconditioning.

The booklet is amply illustrated with "before" and "after" photographs of jobs done by the company.

Water Testing Equipment

819

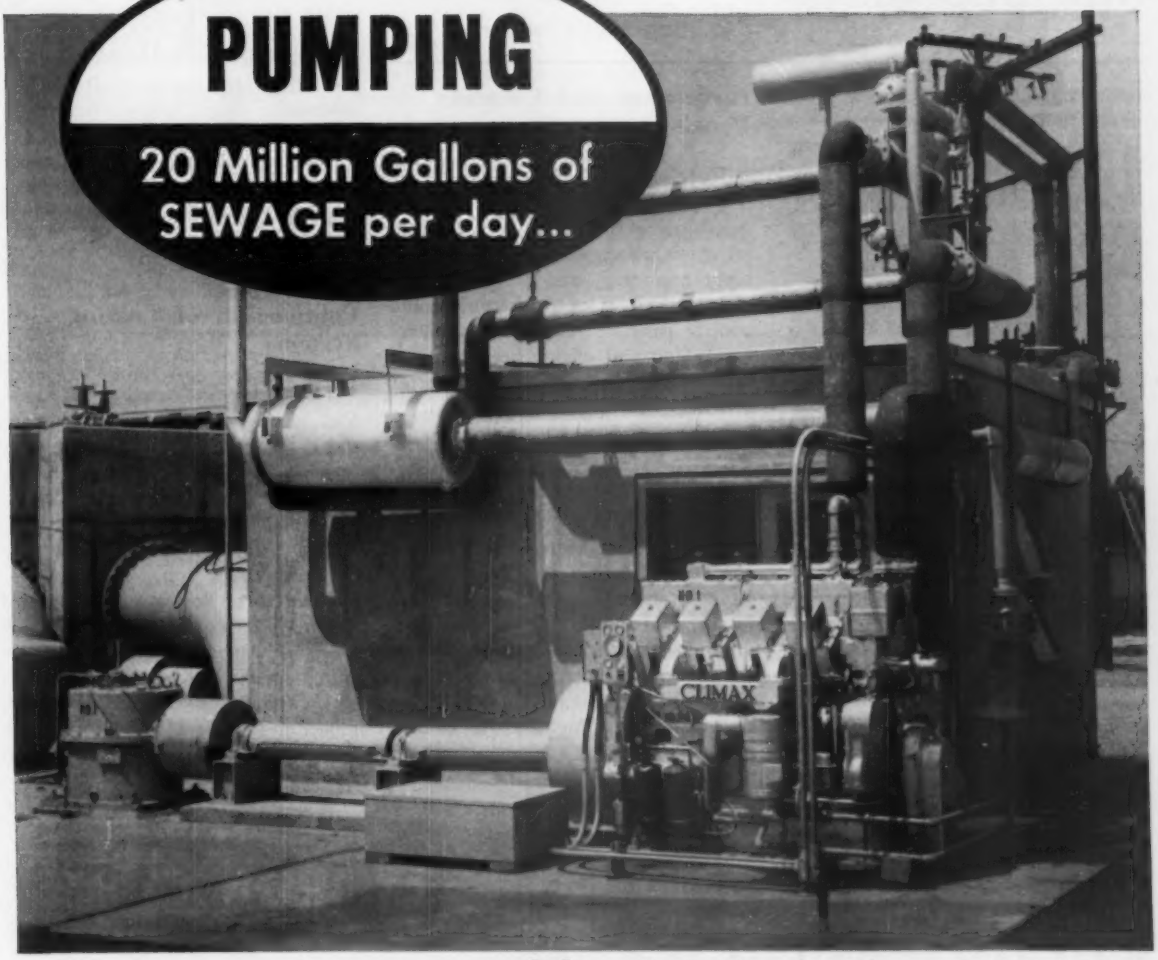
Hagan Chemicals & Controls, Inc., Pittsburgh, Pa., has just published a new bulletin describing equipment and reagents for fast, on-the-spot water testing.

The 12-page bulletin contains sec-

CONTINUED ON PAGE 104A

PUMPING

20 Million Gallons of SEWAGE per day...



at Orange County, California, Sanitation District

two CLIMAX V-85 ENGINES *power the pumps*

Driving centrifugal pumps, two Climax V-85 Engines running at 775 rpm, pump approximately 20 million gallons of sewage per day in Plant No. 1 of the County Sanitation Districts of Orange County, Calif., at Ellis and Verano Streets, Santa Ana. These V-85 Climax Engines —8-cyl., 7½-in. bore x 7-in. stroke, 2474 cu. in. displacement—are burning sludge gas from the digesters; when this gas is not available the engines are automatically switched over to butane fuel. They operate with vapor phase cooling, and the waste heat is used in the digesters. The Climax V-8, unusually compact in design, packs more power into less space. Rugged, too, for durability with dependability in continuous duty sewage plant service. Its famous fuel economy is built-in. For all its plus-value features in detail, get Bulletin SA-584.

CL-109

CLIMAX ENGINE MANUFACTURING CO. • DIVISION OF WAUKESHA MOTOR COMPANY
FACTORY—CLINTON, IOWA

New Bulletins

CONTINUED FROM PAGE 102A

tions on colorimetric test units, conductivity meters for measuring solids, Hagan's Line Operated pH Meter, water hardness test units—including the Calgon Speedy-Kit pocket unit and the Calgon Zeo-Kit, burette titration units, ion exchange units for measuring solids, simple dropper test units and, finally, mechanical devices for sampling water and steam.

Torque-Flow Pump

820

Wemco, a Div. of Western Machinery Company, San Francisco, Calif. has announced the availability of a four page bulletin describing the varied industrial applications of its non-clog Torque-Flow Pump.

The bulletin uses applications in industries to illustrate how the radical new design principle incorporated in this pump makes it completely non-clog, highly abrasion resistant, yet gentle enough to handle delicate materials without damage.

Instrument and Control Panels

821

Bailey Meter Co., Cleveland, Ohio, has published a 16-page product Specification giving details of construction, dimensions, weights, instrument mounting, and accessories for six standard styles of instrument and control panels. Standard procedures for tubing and wiring are presented along with convenient check list for ordering or requesting quotation.

Chemical Solution Feed Pump

822

Fischer & Porter Co., Hatboro, Pa., has released a new Specification Bulletin describing their chemical solution feed pump featuring a hydraulically balanced Teflon slack diaphragm not directly connected to plunger. Diaphragm is unconditionally guaranteed for the life of the pump.

Steel Water Pipe

823

Armco Drainage & Metal Products, Inc., Middletown, Ohio has issued a new illustrated folder on its welded steel water pipe. Subjects treated are wide range of diameters and wall thicknesses; durability, rigid testing, lengths up to 50 ft; high flow capacity; high strength; and field fabrication.

Comparison of Coating Systems

824

The Carboline Company, St. Louis, Mo. has released a new four page chart "Comparison of Maintenance Coating Systems" designed to aid all engineers and maintenance personnel concerned with buying and specifying corrosion resistant maintenance protective coatings.

The chart compares 17 standard systems showing the strong and weak points of each. Accurate resistance ratings are listed for acid, alkali, solvent, water, weathering, flexibility, impact and abrasion, and temperature conditions. Compatibility over old

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AUTOMATIC ENGINE CONTROLS

SPEED SENSITIVE SWITCHES
Overspeed and Underspeed

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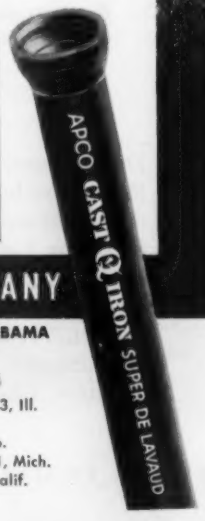

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(*Advertisement*)

20-FT. DELAVAUD CAST IRON PRESSURE PIPE AVAILABLE SOON

Griffin-20 Trademark

COUNCIL BLUFFS. First to produce a complete line of cast iron pressure pipe in modern 20-ft. lengths in the 4- to 12-inch diameter size range by the Delavaud process will be the Council Bluffs foundry of the Griffin Pipe Division, Griffin Wheel Company. Selection of Griffin-20 as its trademark will apply to all pipe, which will be manufactured in accordance with A.W.W.A., A.S.A., and Federal Specifications of cast iron pressure pipe for water and gas distribution.

Pipe Available March, 1960

Conversion of the existing Griffin foundry, and the installation of pipe-producing equipment are well under way, and scheduled for completion in a few months. Joints to be offered include slip-on, mechanical, and bell and plain end. All pipe will be either cement-lined to full specification thickness, half thickness, or uncoated, as required.

10% Fewer Joints

Market surveys conducted among water works operators, city engineers, consultants, and piping contractors in the Plains States overwhelmingly pointed to the need for longer lengths to help reduce mounting labor costs in installing pipe. Griffin-20 pipe decreases the number of joints by 10 percent, as compared to conventional 18-foot lengths, with resultant savings in handling and installation.

Many Foundry 'Firsts'

In its 82-year history, Griffin research has made many contributions to the advancement of foundry practices in ferrous metallurgy, including the de-sulphurization of molten metal with the use of briquetted soda ash known as Purite; the hot blast cupola; use of tellurium for improved chill control in the manufacture of chilled iron castings; and many others. More recently, Griffin perfected a process for the pressure pouring of molten ferrous metals in permanent graphite molds. Griffin's new research center, now under construction in Bensenville, Illinois, will also include facilities for pipe research and developing pipe products.

American Steel Foundries Subsidiary

In addition to the Council Bluffs pipe foundry, Griffin now operates foundries in St. Paul; Denver; Salt Lake City; Tacoma; Kansas City and Muncie, Kansas; Chicago; Cincinnati; Colton, California; and two in Canada. Griffin is a subsidiary of American Steel Foundries, which has 27 plants in 15 states and Canada.

paint, surface preparation and general comments are included.

Use of this chart will help avoid incorrect selection of generic types and at the same time enable choosing the most effective protection for the plant.

Protective Coating

825

The Arco Company, Cleveland, Ohio, has just published a new booklet on Arco Dum Dum for Metal, a heavy protective coating.

The booklet explains the type of protective coating represented by Dum Dum for Metal, lists representative industries that have used it and discusses its protective qualities. Case histories of actual applications, as well as laboratory tests are cited as proof of the claims made for the material's ability to protect exposed metal surfaces.

Fiberglass Filter Wash Troughs

826

B-I-F Industries, Inc., Providence, R. I., has just published a bulletin on fiberglass filter wash troughs that are maintenance-free, light weight, weather and sun resistant and easy to level.

According to the bulletin, the troughs are carefully designed by engineers experienced in filter construction details, and are made entirely of fiberglass reinforced polyester laminate. The surface is hard, highly corrosive-resistant, smooth and never needs chipping or painting. All metal fastenings are of stainless steel. Built-in trapezoidal stiffners give maximum rigidity in net lengths up to 21 feet.

The four page bulletin contains a photograph of the filter wash troughs, descriptive text, detailed specifications, information on installation and construction, and a line drawing giving dimensions.

Low Pressure Compressors

827

Joy Manufacturing Co., Pittsburgh, Pa., has just published a new eight page bulletin covering the company's complete line of heavy duty, low pressure compressors.

F&P "Quick Shipment" Catalog & Price List

828

Fischer & Porter Co., Hatboro, Pa., has just published a 52 page catalog on process instruments available for quick shipment.

CONTINUED ON PAGE 106A

Re-new your structures with GUNITE!

★ durability
★ economy
★ flexibility

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- TUNNELS
- GRAIN ELEVATORS
- BREAKWATERS
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- Recording and Indication when Desired
- Suppressed Head Type
- Any Distance between Transmitter & Receiver

The RTM Roto-Trol operates on the time impulse principle. A tested and proved switching mechanism is operated by a powerful dual motor drive. The motor starters can be controlled direct from the heavy duty mercury switches.

Write for New Bulletin RTM

HEALY-RUFF Company

783 Hampden Ave., St. Paul 14, Minn.

New Bulletins

CONTINUED FROM PAGE 105A

Spectrophotometer

829

Beckman/Scientific and Process Instruments Div., Fullerton, Calif., has available a new six page brochure, Accessories for the Beckman Model B Spectrophotometer.

Butterfly Valves For Altitude Tank Control

830

B-I-F Industries, Inc., Providence, R. I., has published a new bulletin describing the use of a Builders-Providence Butterfly Valve with a B-I-F Altitude Valve Controller for making an efficient, low cost altitude valve.

Plating Waste Treatment

831

Graver Water Conditioning Co., New York, N. Y., has available a paper on Variations in the Design of Plating Waste Treat Systems.

This article, discusses the various systems and methods, both batch and continuous, which may be used in the treatment of hexavalent chromium, cyanides, acids and alkalis.

C. B. & I. Services Booklet

832

Chicago Bridge & Iron Co., Chicago, Ill., has available a 4-page booklet entitled, "Creative Craftsmanship in Steel." The booklet describes the coordination engineering, fabrication and erection services offered by the company.

Technical Data Catalog

833

Lefax Publishers, Philadelphia, Pa., has just revised their 1959 catalog of Lefax Pocket Size Technical Data Books.

The books listed in the catalog contain about 140 loose leaf pages of up-to-date material.

Centralized Control Systems

834

Protection Controls, Inc., Chicago, Ill., has just published a 4-page bulle-

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Trade Mark Reg. U.S. Pat. off.

THE MODERN ALL-PURPOSE FILTERING MEDIUM

Best for All Types of Filters

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offers important advantages over sand and quartz

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KEEPS filters in service over longer periods.
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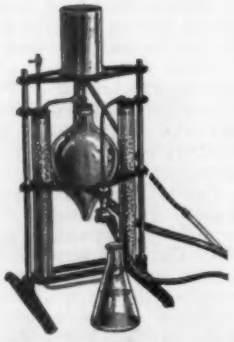

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WRITE:

Phipps & Bird, Inc.

P. O. Box 2V Richmond 5, Va.

tin describing "packaged" centralized control systems.

The bulletin illustrates various custom-engineered control panels which combine a wide range of sequencing, supervising, indicating and power controls for industrial processes, etc.

Grating & Partitioning Catalogs

835

The Globe Company, Chicago, Ill., has just issued two new catalogs on Safety Grip Strut Grating and Safe-Gard metal partitioning.

The grating catalog describes two products, Safety Grip Strut Grating, of one piece construction in steel, aluminum and stainless steel, and also the Gold Nugget welded grating which is projection welded for greater rigidity and strength.

Dry Chemical Feeders

836

Infilco Inc. Tucson, Arizona, has just published a 16-page bulletin on volumetric extrusion type dry chemical feeders.

The bulletin discusses the construction and operation of the Company's E feeders.

Index of Technical Literature

837

Minneapolis-Honeywell Regulator Co., Philadelphia, Pa., has available the new Honeywell Index of Literature.

This 24-page bulletin lists Industrial and Valve Division literature.

Product Catalogs contain operating principles, instrument characteristics, application data, general specifications and ordering information.

V Notch Weir Meter

838

Burgess-Manning Co., Penn Instruments Div., Philadelphia, Pa., has available a 4-page bulletin on the use of the Type ML Meter as applied to weir boxes for measurement of flow across 90° V Notch Weirs.

The bulletin presents an introduction to the new type meter, and lists the advantages of installation.

CONTINUED ON PAGE 108A

KOMLINE-SANDERSON PNEUMATIC SEWAGE EJECTOR SYSTEMS PROVIDE:

ASSURANCE—of carefully designed equipment, ruggedly constructed to give exceptionally long life and maintenance-free service.

ACCEPTANCE—of Komline-Sanderson Ejectors by more and more municipalities proves their worth

APPROVAL—of design application and components of ejectors by prominent consulting engineers insures your satisfaction.

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"Gunite" is the modern process (sand and cement applied pneumatically) for repairing, constructing, lining:

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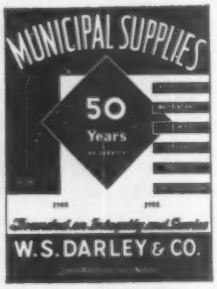

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Sanitary Engineer to direct Division of Sanitation with generalized program in well established County Health Department. Population: 82,000. Liberal vacation, sick leave, retirement, longevity benefits. Cattaraugus County Health Department, 302 Laurens Street, Olean, New York. Salary: $6,564-$7,620.

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Must be graduate in public health, sanitary, chemical or any other appropriate engineering curriculum. Eligibility for a Grade 1 public water treatment and purification plant operator's certificate and a Grade 1 sewage plant operator's certificate issued by New York State. Send resume and application to Mayor Ivers J. Norton, City Building, Olean, New York

New Bulletins

CONTINUED FROM PAGE 107A

Proportioning Pump

839

B-I-F Industries, Inc., Providence, R.I., has just published a new bulletin describing Proportioneers Model 1106 Adjust-O-Feeder designed for the accurate proportioning of general industrial fluids.

Asbestos-Cement Pipe Film

840

The Asbestos-Cement Pipe Division of Keasbey & Mattison Company, Ambler, Pennsylvania has announced the availability of a new sound-color 16MM movie highlighting the manufacture, installation and advantages of asbestos-cement pipe.

Protective Coatings

841

The Carboline Company, St. Louis, Mo., has just issued a completely revised four page bulletin on protective coatings.

The bulletin gives a breakdown of the four classifications of corrosive conditions according to severity of exposure. Sketches of appropriate areas are shown in each grouping.

Plastic Sewer & Drain Pipe Manual

842

Carlon Products Corporation, Aurora, Ohio, has just published a 12-page manual giving complete specifications and test data on Carlon "D" plastic sewer and drain pipe.

The booklet details the recently established industry specifications for plastic drain pipe, and additional data resulting from three years of tests with Carlon "D". Comparison

Water Well Development

843

Edward E. Johnson, Inc., St. Paul, Minn., has just published a bulletin describing the engineering principals of the development of water wells in sand and sand-gravel water-bearing formations.

The publication explains and illustrates the function of a well screen with "V" openings in the development of a highly permeable, natural gravel envelope around the screen.

Surge Relief Valves

844

Golden Anderson Valve Specialty Co., Pittsburgh, Pa., has just published a bulletin describing how the protection of water lines against overpressures in the system can be overcome by the surge relief valve. Ac-

Filter Fabric Co. Lists Products & Services

845

TechFab, Inc., Nutley, N. J., has available an 8-page bulletin describing the products, facilities and services of this firm which offers a complete line of imported and domestic filter cloth, both yard goods and fabricated, filter specialty items and free filtration counseling and testing service.

Automatic Colorimetric Analyzer

846

Florida Instrument Co., Div. of Milton Roy Co., Philadelphia, Pa., has released a 2-page bulletin describing their new Chemalyzer comparator for automatic determinations of water hardness, pH, residual chlorine, phosphate, hydrazine and dissolved iron concentration.

Magnetic Flowmeter Catalog

847

Fischer & Porter Co., Hatboro, Pa., has just released a 6-page catalog giving complete information on F & P obstructionless Magnetic Flowmeter for metering difficult liquids such as concentrated acids, and alkalis, slurries, paper pulp, waste sludges, sewage, etc.

Corru-Drain

848

Graver Water Conditioning Co., New York, N. Y., has published a Fact Sheet containing information on Corru-Drain, unique underdrain for rapid sand filters.

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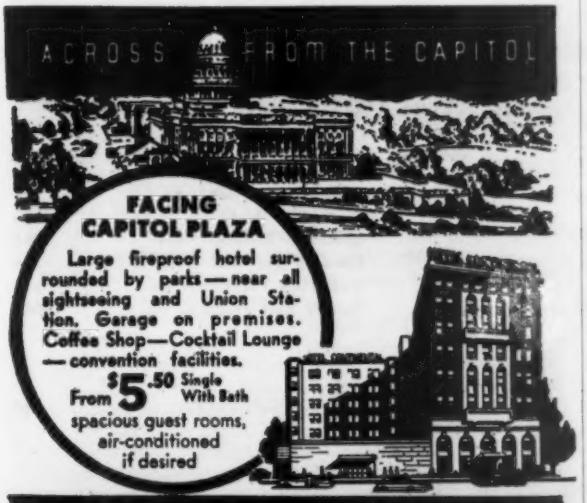
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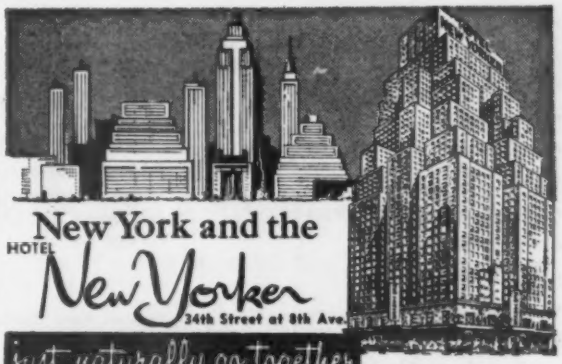

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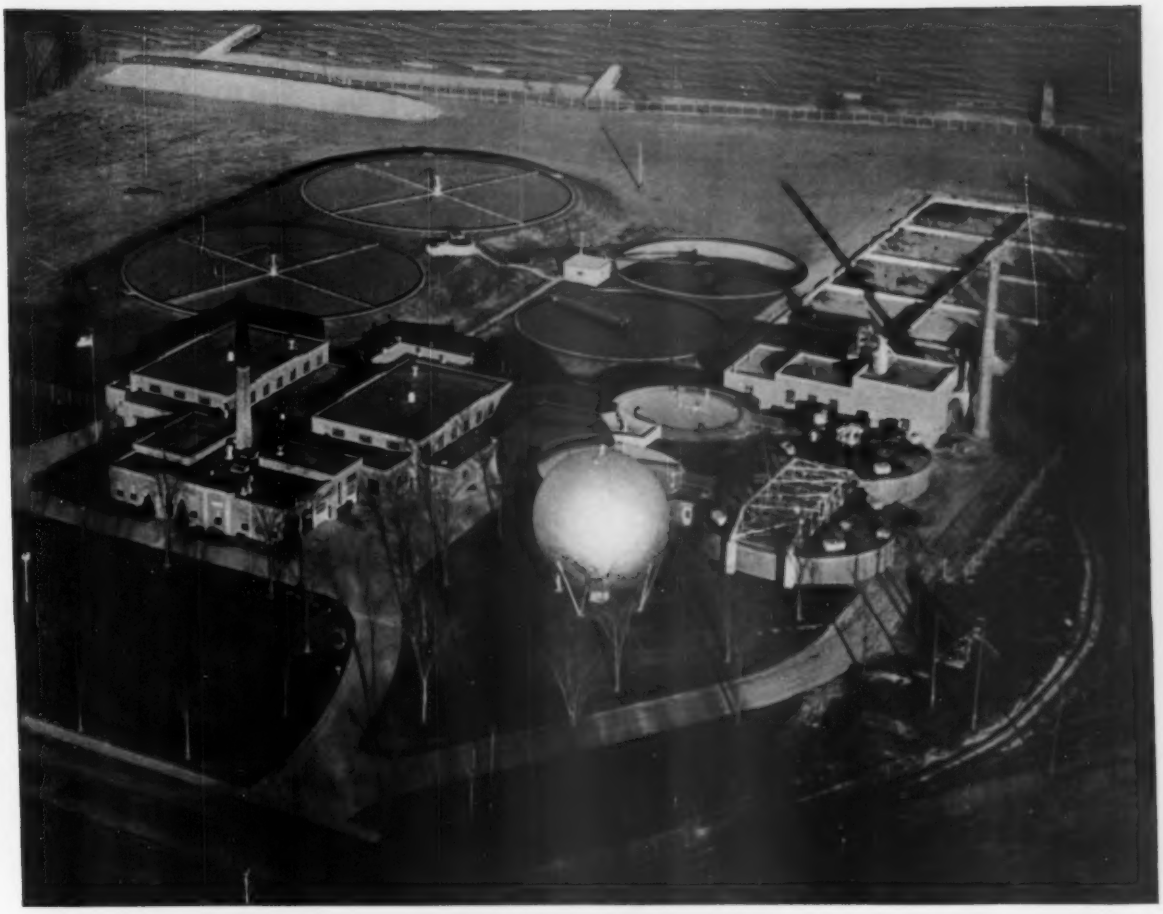

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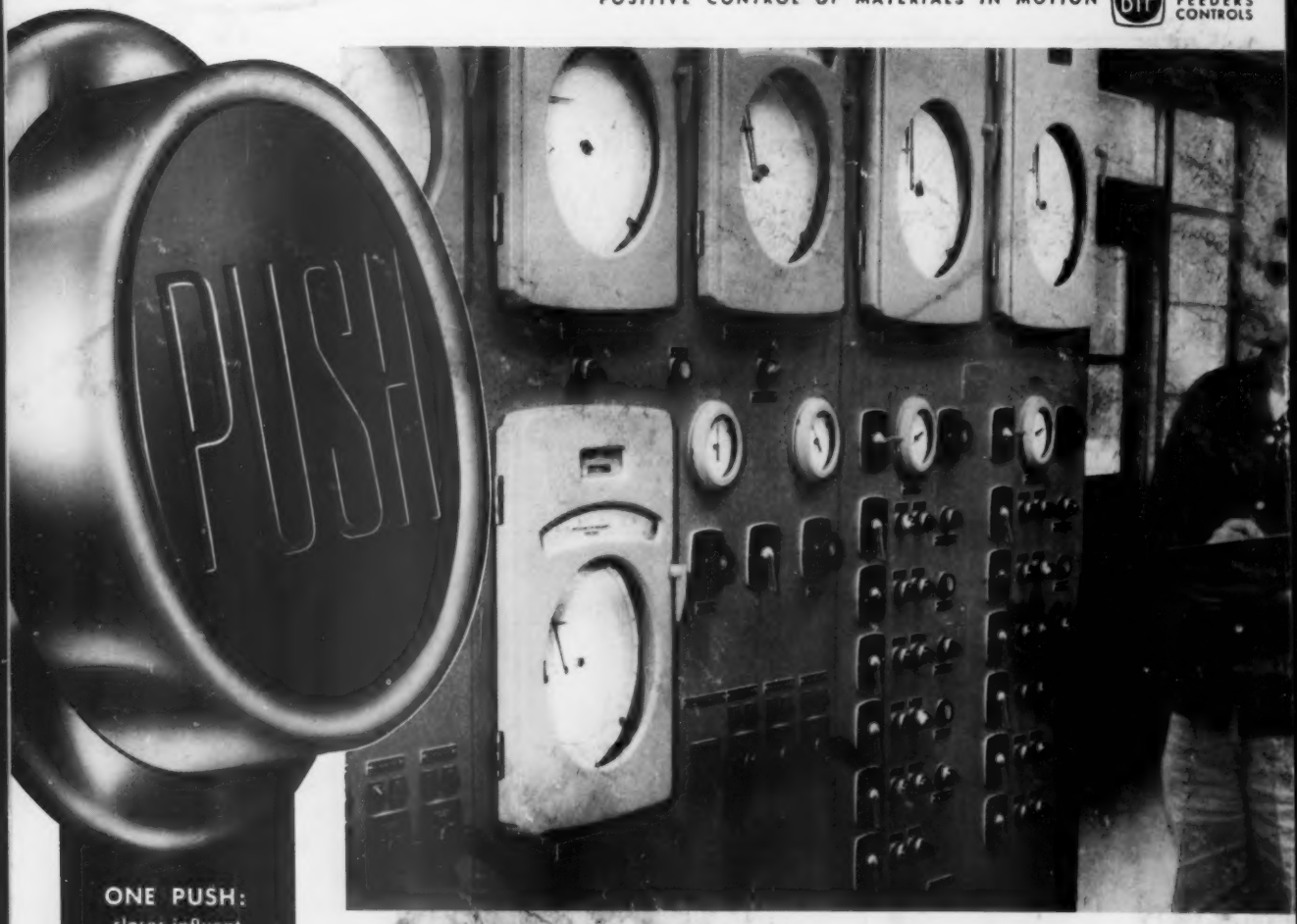

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